INSTRUCTION MANUAL

3111A &
3111B Schematics

SELECTIVE VOLTMETER

RYCOM
instruments, inc.

RYCOM INSTRUMENTS
Railway Communications, Inc.
9351 East 59th Street
Raytown, Missouri 64133

INSTRUCTION MANUAL

3111A & 3111B Schematics

SELECTIVE VOLTMETER

Serial No. 174

(Manual Part No. 0300000400)

Addendum

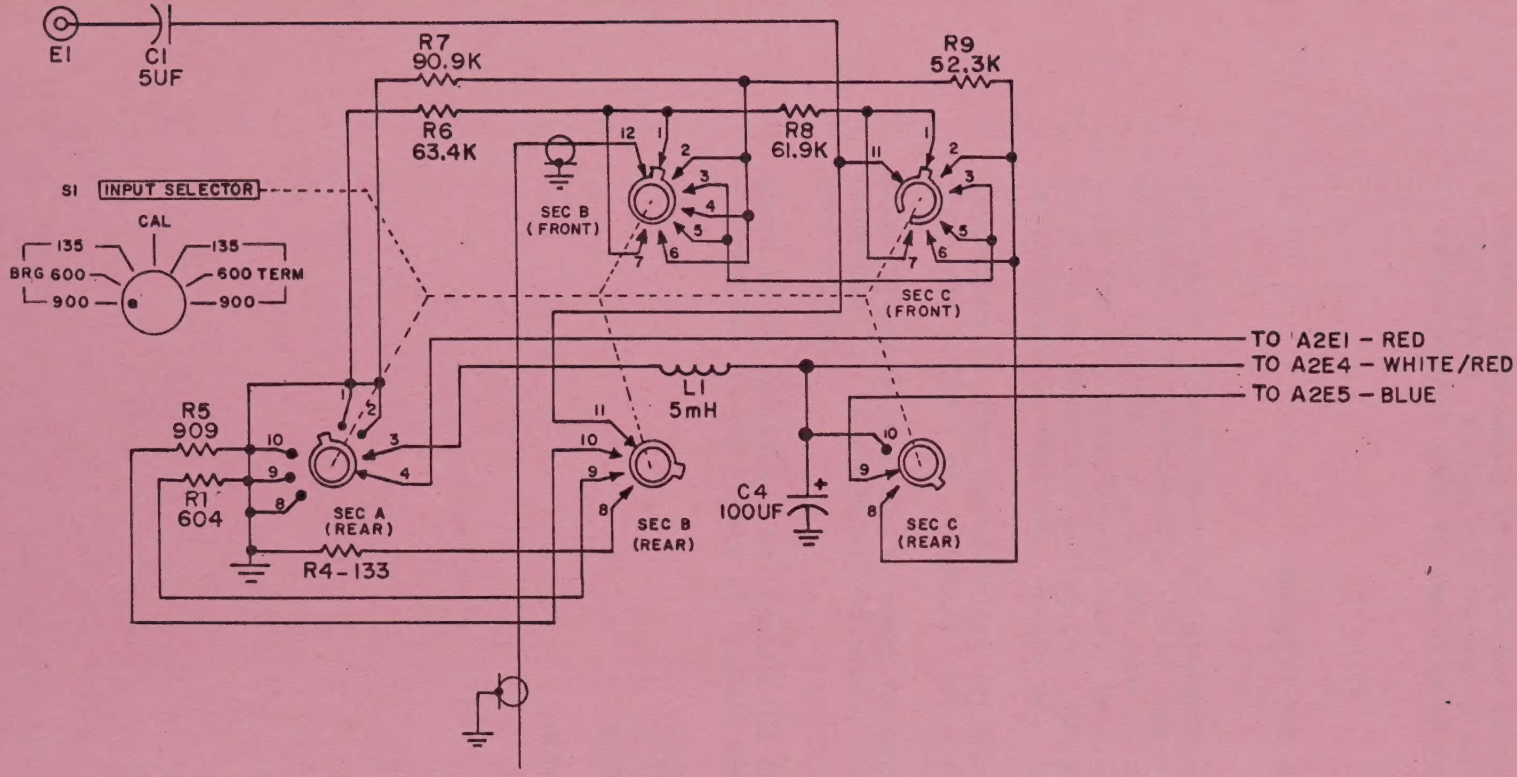
This manual was written for the Model 3111, 3111A Selective Voltmeter. The Model 3111B Selective Voltmeter input switching has been redesigned to contain automatic ranging.

The Model 3111B INPUT SELECTOR switch now contains 135-, 600-, and 900-ohm, Terminate position and 135-, 600-, and 900-ohm, Bridge position, and CAL position. Under Bridge conditions the input impedance remains 100,000 ohms.

The unit has automatic ranging in all positions, and will be accurately calibrated for 135-, 600-, 900-ohms in both BRG and TERM positions.

A schematic diagram of the 3111B Input circuit is on the following page.

A new manual will be sent to you as soon as we receive them.



C4	Cap, 100 uF, (+100, -10%), 16 wvdc, elect'c
L1	Coil, RF, 5 mH
R1	Res, 604 ohms ±1%, 1/4 W at 125°C
R4	Res, 133 ohms ±1%, 1/4 W at 125°C
R5	Res, 909 ohms ±1%, 1/4 W at 125°C
R6	Res, 63.4 k ohms ±1%, 1/8 W at 70°C
R7	Res, 90.9 k ohms ±1%, 1/8 W at 70°C
R8	Res, 61.9 k ohms ±1%, 1/8 W at 70°C
R9	Res, 52.3 k ohms ±1%, 1/8 W at 70°C

Model 3111B Input Selector Schematic

CERTIFICATION

RYCOM Instruments Incorporated certifies that this instrument was thoroughly tested and inspected and found to meet its published specification when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All RYCOM Instruments Inc. products are warranted against defects in material and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed below for the specified period. We will repair or replace products that prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

Exceptions to this warranty are dry batteries or Rechargeable batteries which are subject to original manufacturer's inspection and warranty.

This warranty is void if, after having received the instrument in good condition, it is subjected to abuse, unauthorized alteration or unauthorized repair.

Where it is necessary to return the instrument to the factory, furnish information to the nature of trouble encountered. Ship prepaid to:

RYCOM INSTRUMENTS, INC.
9351 East 59th Street
Raytown, Missouri 64133

Attention: Service Department

LIST OF EFFECTIVE PAGES

Total Number of Pages in This Publication is 57

Page No.	Issue	Page No.	Issue
Title	Original	15 thru 47	Original
Warranty	Original	48 Blank	Original
A	Original	49	Original
B Blank	Original	50 Blank	Original
i thru iii	Original		
1 thru 3	Original		
4 Blank	Original		
5 thru 13	Original		
14 Blank			

This manual applies to the following units:

Model 3111 Selective Voltmeter, Serial Numbers 101-400.
Model 3111A Selective Voltmeter, Serial Numbers 401 up.

*An asterisk indicates pages changed, added, or deleted by the latest revision.

TABLE OF CONTENTS

Page

CHAPTER I GENERAL

1. Purpose of Manual 1
2. Purpose of Equipment 1
3. Description of Equipment 1

CHAPTER II OPERATION

1. General 5
2. Operating Controls, Input, and Output Terminations 5
3. Preliminary Checks 6
4. Battery Charging 7
5. Calibration 7
6. Operation 8
7. Recorder Output 9
8. Restored Frequency Output 9
9. Audio Amplifier Operation 9

CHAPTER III THEORY OF OPERATION

1. General 10
2. Block Diagram Theory 10
3. Detailed Circuit Theory 12

CHAPTER IV MAINTENANCE

1. Introduction 21
2. Test Equipment 21
3. Maintenance 21
4. Trouble Shooting 21
5. Parts Replacement 30
6. Alignment 30

CHAPTER V PARTS LIST

1. How to Order Parts 33
2. List of Manufacturers 33

LIST OF TABLES

Table No.	Description	Page
1	Specifications	2
2	Operating Controls, Input, and Output Terminations	5
3	Test Equipment	21
4	Trouble Shooting Chart	22
5	Transistor Voltage Chart	24

LIST OF ILLUSTRATIONS

Figure No.	Description	Page
1	Model 3111A Selective Voltmeter	iii
2	Block Diagram	13
3	Transistor Terminations and Trouble Shooting	25
4	Component and Test Point Locations	26
5	Module A2 Circuit Board	27
6	Module A3 Circuit Board	27
7	Module A4 Circuit Board	28
8	Component Location	29
9	Test Setup, Calibrate Oscillator Alignment	30
10	Test Setup, Local Oscillator Alignment	31
11	Schematic Diagram, 3111A Selective Voltmeter	49

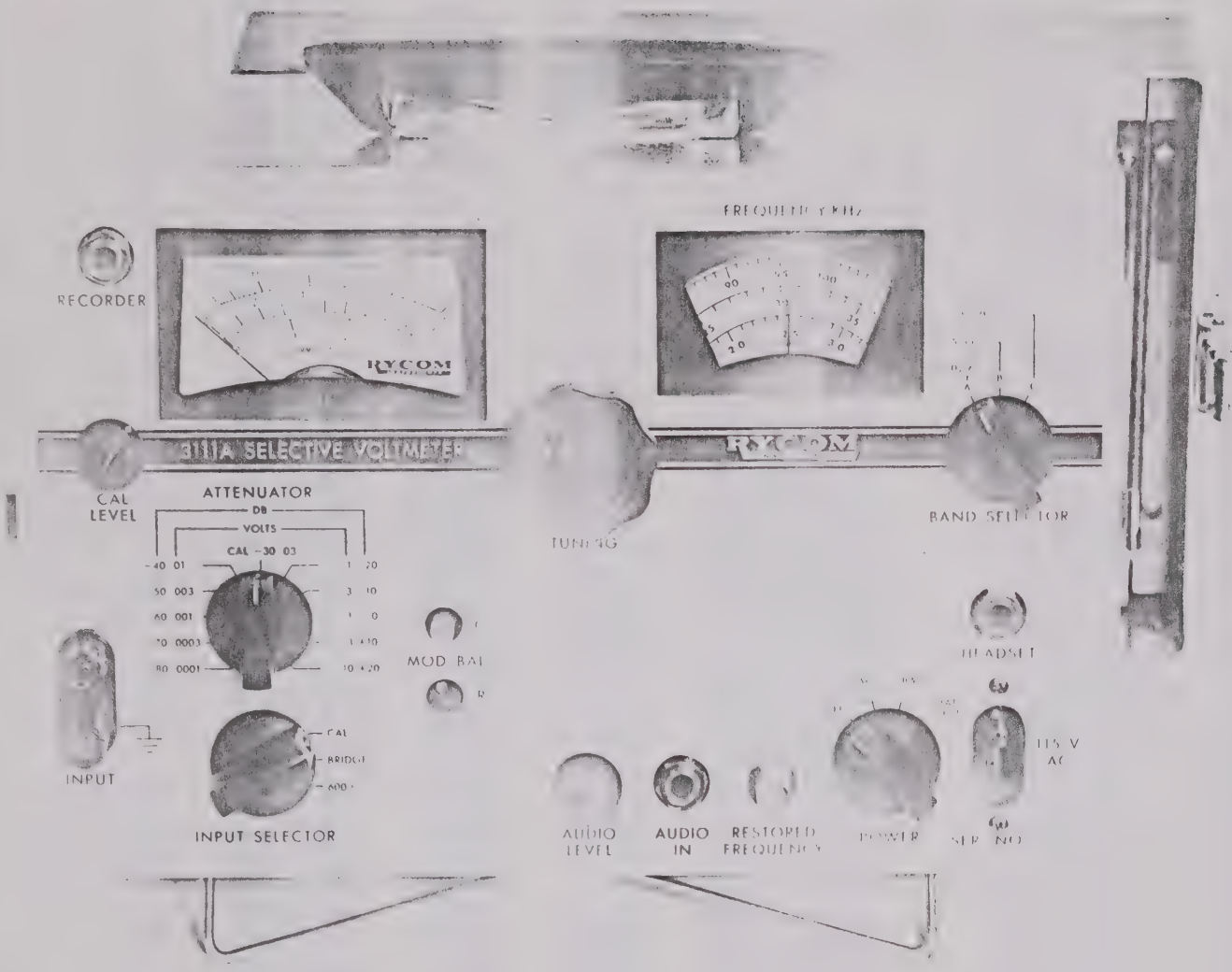


Figure 1. 3111A Selective Voltmeter

CHAPTER I
GENERAL

1. PURPOSE OF MANUAL.

This manual contains the operation and maintenance instructions for the RYCOM Model 3111A Selective Voltmeter. The instrument is illustrated in Figure 1.

2. PURPOSE OF EQUIPMENT.

The Model 3111A Selective Voltmeter is intended for use in the measurement of voltage and power levels at a specific frequency in the range of 20 Hz to 150 kHz, through a highly selective tuning circuit and 25 Hz passband filter. The instrument is extremely useful for analyzing closely spaced signals (such as telemetering tones), complex waveforms, determining carrier system levels, and checking percentage of amplitude modulation.

3. DESCRIPTION OF EQUIPMENT.

The Selective Voltmeter is a compact, fully transistorized precision instrument. The instrument can be operated from the rechargeable Ni-Cad battery for periods up to 35 hours without recharging. Operation from 115 volt ac power lines at frequencies from 50 to 60 Hz is provided when the polarized power cord is connected to the equipment at the front panel connector. Operation from the ac power lines is possible regardless of battery condition, from the self-contained battery charger.

Outstanding features include an internal oscillator for self-calibration purposes, a restored frequency signal output, a recorder output jack, and audio amplifier input and output jack, and a speaker for aural indication of the measured signal.

A major portion of the circuitry is contained on three printed circuit boards. Each of the boards perform a major operational function: 1) input signal processing, 2) local oscillator, 3) I-f signal processing. Extensive shielding is provided to prevent interaction between circuits.

The instrument is housed in a rugged metal cabinet. Operating controls and connection points are all located on the front panel for accessibility. The controls and connection points are protected from damage during transporting by a removable front cover. The cover cannot be secured in place unless the POWER switch is in the OFF position, thereby preventing battery discharge while the instrument is not in use.

The primary characteristics, capabilities, overall weight, and dimensions are listed in Table 1.

Table 1. Specifications

CHARACTERISTIC	SPECIFICATION
FREQUENCY RANGE	20 Hz to 150 kHz (3 bands) Band A: 20 Hz to 6 kHz Band B: 5 kHz to 55 kHz Band C: 50 kHz to 150 kHz
FREQUENCY ACCURACY	Dial: Band A ±20 Hz Band B ±200 Hz Band C ±300 Hz
INPUT LEVEL	7.75 uV to 10 V: -100 to +22 dB (reference 0 dBm 600 ohms).
INPUT IMPEDANCE	100 k ohms BRIDGE and 600-ohms (200 V DC blocking).
MEASUREMENT ACCURACY	+0.5 dB (typically ±0.1 dB flatness over frequency range).
SELECTIVITY CRYSTAL FILTER	25 Hz nominal at 3 dB down 80 Hz maximum at 60 dB down
INTERNALLY GENERATED HARMONICS AND INTERMODULATION DISTORTION	-70 dB or better (with 50 dB sensitivity increase).
IMAGE, SPURIOUS, AND I-F REJECTION	-60 dB or better
RECORDER OUTPUT	1 mA dc into 100 ohms.
RESTORED FREQUENCY OUTPUT	Restored signal frequency level is proportional to meter reading Full scale approximately 1.0 V across 10,000 ohms
AUDIO AMPLIFIER	Input: 0.1 volt minimum across approximately 20,000 ohms for maximum level out. Output: 1 volt across 125 ohms.
TYPE OF DETECTION FOR AURAL INDICATION	BFO for 1,000 Hz tone.
POWER SUPPLY	Internal 12 volt Nickel-Cadmium battery. AC operation and Battery charging from 90 to 130 volt, 50 to 60 Hz source.

Table 1. Specifications (Cont)

CHARACTERISTIC	SPECIFICATION
TEMPERATURE RANGE	+10°C to +50°C.
DIMENSIONS	8 inches high x 12 inches wide x 9 inches deep, over removable cover
WEIGHT	15 pounds

CHAPTER II
OPERATION

1. GENERAL

The instrument has been thoroughly inspected at the factory and is covered by warranty. However, before using the instrument, you should inspect it for shipping damage. Report any damage to the carrier and to RYCOM Instruments, Inc.

2. OPERATING CONTROLS, INPUT, AND OUTPUT TERMINATIONS.

The operating controls, input, and output terminations for the instrument are listed in Table 2.

Table 2. Operating controls, Input, and Output Terminations.

PANEL MARKING	DESCRIPTION	FUNCTION
BAND SELECTOR	3-position rotary switch	Selects frequency of band to be tuned.
TUNING	Driven tuning mechanism, 2-speed	Tunes the instrument to frequency as indicated on the dial for selected band.
ATTENUATOR	11-position rotary switch	Selects sensitivity in 10-dB steps, -80 dB thru +20 dB or in volts, .0001 to 10 volts.
INPUT SELECTOR	3-position rotary switch	Selects input impedance or self-calibration feature. BRIDGE = 100,000 ohms.
CAL LEVEL	Potentiometer	Sets calibration level to 0 dBm on Meter.
AUDIO LEVEL	Potentiometer	Controls audio level to speaker and headset.
INPUT	Binding posts	Signal input for measurements
POWER	4-position rotary switch spring loaded in BAT. TEST position.	Connects power supply to ac line, battery, or battery test circuit.
HEADSET	Telephone jack	Provision for aural monitoring of signal. Disables speaker.

Table 2. Operating controls, Input, and Output Terminations (Cont)

PANEL MARKING	DESCRIPTION	FUNCTION
RECORDER	Telephone jack	Provides 1 mA signal into 100 ohm for recorder drive. Does not disable meter.
RESTORED FREQUENCY	Coaxial connector, BNC	Provides restored frequency signal for driving an external counter.
AUDIO IN	Telephone jack	Provides external input to audio amplifier and disconnects internal signal from audio amplifier.
MOD BAL C	Variable capacitor	Balances capacitance of ring modulator circuit.
MOD BAL R	Potentiometer	Balances resistance of ring modulator.
115 VAC	Polarized connector	Provision for connection to 115-V ac line.
No marking	1/4 in. black knob on FREQUENCY dial bezel. Used on Serial No. 401 up.	Rotates cursor $\pm 5^{o}$ for frequency correction.

3. PRELIMINARY CHECKS.

Complete the following preliminary checks to insure that the instrument has not been damaged internally and the condition of battery charge:

a. Identify power cord WA1 and connect to 115 VAC power connector J1.
b. Place POWER switch in OFF position.

NOTE

The battery has been charged at the factory and should operate the instrument without a preliminary charge cycle. However, if the instrument has been stored for an extended period of time the battery will check low and should be recharged. Follow procedures given in subsequent paragraphs.

c. Position POWER switch to BAT. TEST position (spring loaded) and note meter indication. Meter should indicate 0 dB ±0.5 dB, if reading is below -0.5 dB the battery requires charging. See paragraph 4 for battery charging procedure.

d. Place POWER switch in OFF position.

e. Connect power cord WA1 to source of 90-130 volts ac, 50 to 400 Hz.

f. Place POWER switch in AC (5 ma) position, meter will deflect, indicating powered operation.

g. Place POWER switch in OFF position and proceed with calibration and operating procedures.

4. BATTERY CHARGING

Battery charging is not required when operated continuously from the AC power lines. The AC (5 ma) position of the POWER switch maintains the battery at full charge with the 5 milliamperes trickle charge.

Recommended procedure is to charge the battery regularly at scheduled intervals and at least once a month when regularly used as a portable instrument. Charging is accomplished by connecting the instrument to the AC power source and setting POWER switch to BAT. (65 ma) position. This charges the battery at the rate of 65 milliamperes and requires approximately 24 hours to recharge a completely discharged battery.

5. CALIBRATION

The following procedure should be performed prior to use to insure accurate measurements. Complete the following steps:

a. Apply power to the instrument by placing POWER switch in appropiate position for either AC or battery operation.

b. Set INPUT SELECTOR switch to CAL position.

c. Set ATTENUATOR switch to -30 DB .03 VOLTS CAL position.

d. Set BAND SELECTOR switch to band A, 20 Hz - 6KHz.

e. Adjust TUNING control for maximum indication on meter. FREQUENCY dial will indicate approximately 2.5 KHz.

f. Set red cursor on FREQUENCY dial to 2.5 KHz.

g. Adjust CAL LEVEL control for 0 dB indication on meter.

NOTE

Calibration procedures should never be performed with a signal connected to the INPUT terminals.

h. Proceed with operating procedures upon completion of calibration.

6. OPERATION

Typical operating procedures are given as a guide to operating only. Modification of the procedures is obvious and will be required for each particular measurement and techniques employed. When making line measurements below 300 Hz, place the instrument face up (resting on the four rubber feet) and remove the AC line cord from the 115 VAC receptacle. Set POWER switch to BAT. position. This places approximately 100 picofarads of unbalance to ground from the ground terminal of the instrument.

a. Line Measurements

(1) Calibrate instrument per preceding paragraph 5 and operating.

(2) Connect line to be measured to INPUT terminals.

(3) Set INPUT SELECTOR switch to desired position, BRIDGE or 600 ohms.

(4) Set BAND SELECTOR to frequency range of signal to be measured and adjust TUNING control to desired frequency.

(5) Position ATTENUATOR switch to give a meter indication in the upper two-thirds of the scale.

(6) Adjust TUNING control for maximum meter indication.

(7) To determine the level of input signal accurately, the meter indication in VOLTS or DB is added algebraically to the value indicated by ATTENUATOR position.

(8) After completion of measurements disconnect input signal from instrument INPUT and place POWER switch in the OFF position.

b. Measurements below 50 Hz

(1) Calibrate instrument per preceding paragraph 5 and operating.

NOTE

Do not connect line to INPUT terminals until instructed to do so in procedural steps.

(2) Set INPUT SELECTOR switch to BRIDGE position.

(3) Set BAND SELECTOR switch to band A.

(4) Adjust TUNING control to low end of band A until meter indicates approximately 0 dB.

(5) Adjust MOD BAL C for minimum meter indication.

(6) Adjust MOD BAL R for minimum meter indication.

(7) Adjust TUNING until meter indicates 0 dB or maximum indication.

(8) Repeat steps (5), (6), and (7) until meter indication is below -15 dB as TUNING control is adjusted for maximum meter indication.

(9) Connect signal to be measured at INPUT terminals of the instrument.

(10) Proceed with measurements following procedures of paragraph 6.a., Line Measurements.

(11) Repeat steps (5), (6), and (7) during extended periods of operation to insure balance does not change.

(12) Complete measurements and disconnect input.

(13) Place POWER switch in the OFF position.

7. RECORDER OUTPUT

The RECORDER jack will furnish 1 mA into 100 ohms when the meter indicates full scale. Operation of the instrument is not affected by the recorder connection or operation.

8. RESTORED FREQUENCY OUTPUT

The RESTORED FREQUENCY jack will furnish approximately 1 volt into a 10 k ohms (minimum) load when the meter is indicating full scale. The purpose is for supplying output to an electronic counter. The restored frequency signal contains the frequency or frequencies in the bandpass tuned by the instrument. Connection to the RESTORED FREQUENCY jack does not affect other operating procedures or characteristics of the instrument.

9. AUDIO AMPLIFIER OPERATION

The audio amplifier performs a dual function. First, one of amplifying the tuned signal of the beat frequency oscillator (BFO) detected signal, to provide aural monitoring at the speaker or in the headset when connected to the HEADSET jack. Second, the amplifier performs as an auxilliary audio amplifier when a signal is applied to the AUDIO IN jack it automatically disconnects the internal circuit. The AUDIO LEVEL control sets the level in either application. Response of the amplifier is approximately ±3 dB from 100 Hz to 2.5 kHz, input of 0.1 volt (min.) into 20,000 ohms will deliver 1 volt (min.) into a 125 ohm load.

CHAPTER III
THEORY OF OPERATION

1. GENERAL

The following paragraphs cover the theory of operation for the instrument. The Block Diagram Theory will aid in conveying the overall circuit operation in concise from, while the Detailed Circuit Theory will enable the technician to comprehend the operation and circuitry employed in the instrument.

2. BLOCK DIAGRAM THEORY

The following paragraphs together with the Block Diagram, Figure 2, cover in concise form the overall circuit from the standpoint of signal flow and primary function or operation.

a. Input

(1) INPUT SELECTOR S1 selects input impedance desired or the calibration oscillator and couples output to the ATTENUATOR A1S1.

(2) ATTENUATOR A1S1 is a 11-position high impedance attenuator providing attenuation in 10 dB steps. The attenuated signal is applied to the source follower, transistor A2Q1.

(3) Source follower, transistor A2Q1, amplifies the signal and applies the output to emitter follower, transistor A2Q2.

(4) Emitter follower, transistor A2Q2, applies the amplified signal to the input of lowpass filter A2FL1.

(5) Lowpass filter, A2FL1 passing the desired frequency or frequencies couples the output to the ring modulator A2CR1 through A2CR4.

b. Ring Modulator

The ring modulator circuit receiving the signal from lowpass filter A2FL1 and the injection signal from the local oscillator, transistors A3Q1 through A3Q3, develops a signal with a center frequency of 250 kHz for application to i-f amplifier input, filter driver, transistor A2Q5.

c. Local Oscillator

(1) Oscillator, transistor A3Q1, develops a variable frequency in the range of 250.02 kHz to 400 kHz, which is coupled to the modulator driver, transistors A3Q2 and A3Q3.

(2) Modulator driver, transistors A3Q2 and A3Q3, amplify the variable frequency output of the oscillator for application to the ring modulator circuit, diodes A2CR1 through A2CR4 and restored frequency, modulator driver transistor A4Q9.

d. I-f Amplifier and Metering

(1) Filter driver, transistor A2Q5 amplifies the 250 kHz output from the ring modulator for application to bandpass filter A2FL2.

(2) Bandpass filter, A2FL2 is a crystal filter with a 25 Hz passband providing extremely sharp filtering. Output is coupled to first i-f amplifier.

(3) First i-f amplifier, transistors A4Q1 and A4Q2, amplify the signal for application to the second i-f amplifier, transistor A4Q3.

(4) Second i-f amplifier, transistor A4Q3 amplifies the signal and couples it to the third i-f amplifier, transistor A4Q4. Output at this point is coupled out to the buffer amplifier A4Q10 in the restored frequency circuit.

(5) Third i-f amplifier, transistor A4Q4 amplifies the signal and applies it to the meter detector diodes A4CR1 and A4CR2 and to the audio detector balanced modulator, diodes A4CR7 and A4CR8.

(6) Meter detector, diodes A4CR1 and A4CR2 detects the output signal of the third i-f amplifier for application to the meter M1 and for output via the RECORDER jack J2 to drive an accessory recorder.

(7) Meter M1 displays the level of signal or signals present in the passband of the instrument.

e. Audio Detector

(1) Balanced modulator, diodes A4CR7 and A4CR8 receiving the output of the third i-f amplifier and the output of the 249 kHz oscillator, transistor A4Q13, generates a 1,000 Hz signal for aural monitoring the signal or signals in the passband of the instrument. The audio tone is coupled to the audio amplifier for further amplification.

(2) Crystal oscillator, transistor A4Q13 controlled in frequency by A4Y1 develops a 249 kHz signal. The oscillator signal is applied to modulator driver, transistor A4Q12.

f. Audio Amplifier

(1) First audio amplifier, transistor A4Q5, receives the audio output signal of the balanced modulator, diodes A4CR7 and A4CR8 for amplification and coupling to the second audio amplifier, transistor A4Q6. Auxiliary input at AUDIO IN jack J4 automatically disconnects the internal signal input from the balanced modulator.

(2) Second audio amplifier, transistor A4Q6, provides additional amplification for driving the audio output amplifier, transistors A4Q7 and A4Q8.

(3) Audio output amplifier, transistors A4Q7 and A4Q8, amplify the audio signal to the level required to drive the speaker or headset when connected to HEADSET jack J5. Connection to the HEADSET jack automatically disconnects the speaker.

g. Restored Frequency

(1) Modulator driver, transistor A4Q9, receives the local oscillator signal and amplifies it for application to the balanced modulator, diodes A4CR5 and A4CR6.

(2) Buffer, transistor A4Q10, receives the output from the second i-f amplifier, transistor A4Q3 for amplification and application to the balance modulator, diodes A4CR5 and A4CR6.

(3) Balanced modulator, diodes A4CR5 and A4CR6, develops the restored frequency signal by combining the local oscillator signal amplified by modulator driver, transistor A4Q9 and the signal from second i-f amplifier, amplified by transistor, A4Q10. The signal is coupled to the lowpass filter module A6.

(4) Lowpass filter, module A6, receiving the restored frequency signal from the balanced modulator, couples the filtered signal to amplifier A4Q11.

(5) Amplifier, transistor A4Q11, amplifies the signal to the required level and couples the output to RESTORED FREQUENCY jack J3.

h. Calibrate Oscillator

Calibrate oscillator, transistors A2Q3 and A2Q4, develop a 2.5 kHz signal for injection at the input when INPUT SELECTOR switch S1 is in the CAL position.

i. Power Supply

The AC power supply provides the unregulated 15 volt DC power to provide AC operation and battery charging functions in the instrument. Battery BT1 provides 12 volts DC for portable operation, charging is accomplished by AC source. Regulator, transistors A4Q14 and A4Q15 provides a source of regulated DC at 9.4 volts.

3. DETAILED CIRCUIT THEORY

The following sub-paragraphs cover the individual circuits and their operation. Occasional reference to the overall schematic diagram of the instrument, Figure 11 will be necessary to determine circuit configuration.

a. Input

(1) Input selector S1. The input signal applied to INPUT terminals E1 and E2 is coupled from E1 through capacitor C1, 5.0 uF, 200 wvdc, to the

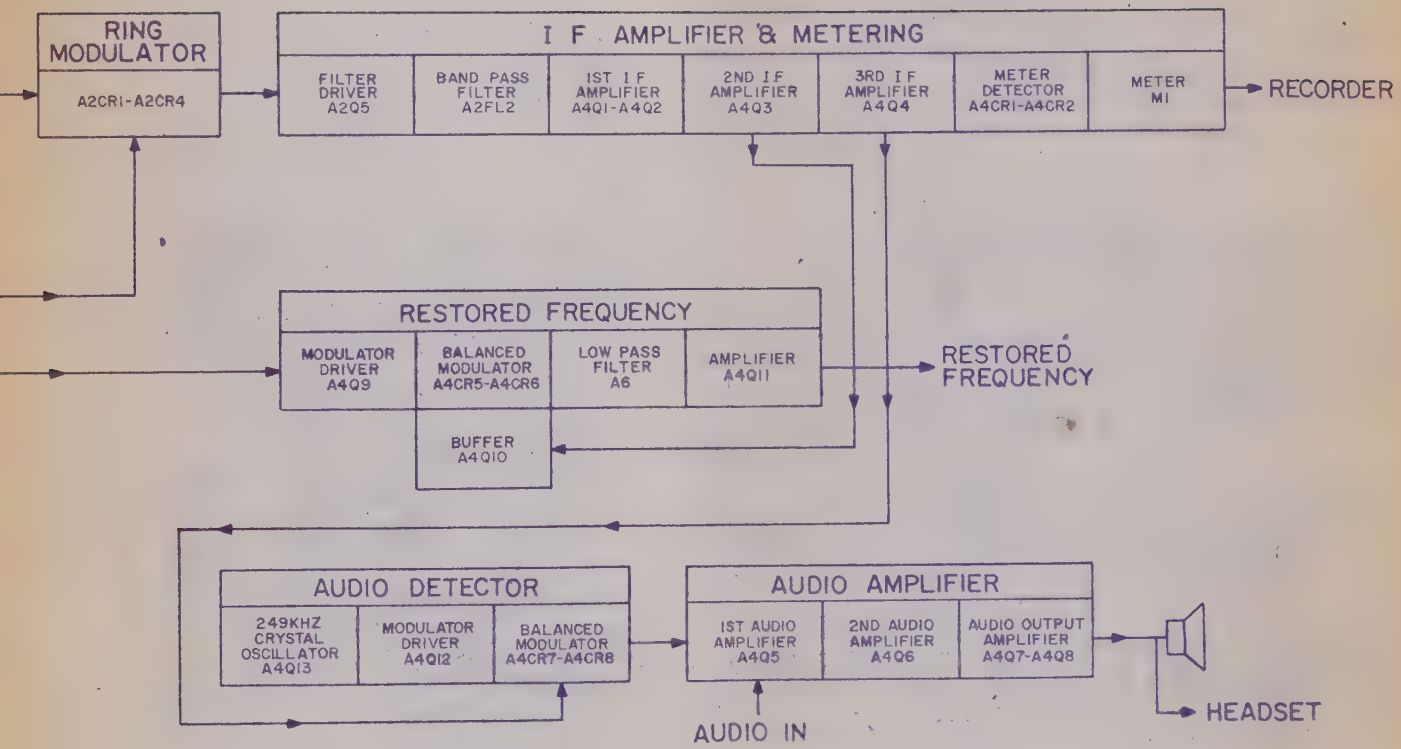


FIG. 2 BLOCK DIAGRAM MODEL 3111 SELECTIVE VOLTMETER

front of wafer on INPUT SELECTOR switch S1. The positioning of INPUT SELECTOR S1 governs the input impedance of INPUT terminals. In the BRIDGE position input empedance is 100 k ohms and the input signal is coupled directly to the ATTENUATOR switch A1S1 through capacitor C1. In the 600-ohm position, the input signal is applied across resistor R1, 604 ohms, through capacitor C1 for an impedance of 600 ohms. The CAL position of the INPUT SELECTOR switch S1 applies power to the oscillator circuit and couples the output to ATTENUATOR module A1.

(2) Attenuator A1S1. ATTENUATOR switch A1S1 provides 11 positions of attenuation in 10 dB steps. Output from the ATTENUATOR module A1 is applied to the source follower, transistor A2Q1. The attenuator module uses two 50 dB L pads, resistors A1R1, A1R2, and A1R3 and A1R4 respectively and stepped series divider, resistors A1R5 through A1R9. Total attenuation of 100 dB is provided in 10 dB steps.

(3) Source Follower, A2Q1. Transistor A2Q1, receives the output ot ATTENUATOR module A1 at the gate through series resistor A2R1 and series capacitor A2C1. Resistor A2R1 in the gate circuit of A2Q1 provides over voltage protection for the field effect transistor. The output of source follower is coupled to emitter follower, transistor A2Q2. The source and emitter followers, A2Q1 and A2Q2, respectively, are bootstrapped by the signal across resistor A2R3 to reduce the generation of undesired signals (harmonics and distortion products).

(4) Emitter Follower, A2Q2. The output from the source follower is direct coupled to the base of transistor A2Q2. The applied signal is amplified and applied to the input of lowpass filter A2FL1 through series capacitor A2C2 and series resistor A2R6.

(5) Lowpass filter, A2FL1. Receives the output signal from transistor A2Q2. The lowpass filter has a cutoff frequency of approximately 190 kHz and an infinite attenuation frequency at approximately 250 kHz. The output of filter is applied to the center tap of ring modulator transformer A2T1 through resistor A2R7.

b. Ring Modulator

The ring modulator, matched quad diodes A2CR1, A2CR2, A2CR3, and A2CR4, and related components, convert the desired signal (20 Hz to 150 kHz) to a 250 kHz i-f signal by using the local oscillator (250.02 kHz to 400 kHz) as an injection source. The local oscillator injection signal from transformer A3T1 drives the diodes of two adjacent arms of the ring modulator alternately to conduction (A2CR1 and A2CR4 or A2CR2 and A2CR3). The diodes employed are the "hot-carrier" type and have a reverse breakdown voltage of less than 10 volts. When alternate pairs of the diodes are in conduction a low impedance ground is placed on alternate sides of transformer A2T1 and switches the input signal current through the primary of transformer A2T1. The voltage induced in the secondary of transformer A2T1 is the input signal with the polarity changing at the rate of the local oscillator frequency. The input

signal after processing in the ring modulator appears as a 250 kHz signal across the secondary of transformer A2T1 with the local oscillator suppressed. Fine adjustment of the local oscillator suppression is accomplished by the MOD BAL controls R, variable resistor A2R103 and C, variable capacitor A2C8. Resistors A2R18 through A2R21 in series with the diodes improve local oscillator suppression by reducing the effect of forward conduction differences of the diodes. Capacitor A2C10 resonates transformer A2T1 to 250 kHz. The output signal across the secondary of transformer A2T1 is applied to filter driver, transistor A2Q5.

c. Local Oscillator

(1) Local Oscillator A3Q1. Transistor A3Q1, is a common base circuit configuration, Clapp type oscillator, covering the frequency range from 250.02 kHz to 400.00 kHz in three bands. Frequency determining elements are transformer A3T2, coil A3L2, and variable capacitor C3 and the individual band set capacitors and related padder capacitors. Coil A3L2 is the inductance trimming element in the tuned circuit and improves frequency tracking on bands B and C, BAND SELECTOR switch A3S3 selects the desired band, A, B, or C, by selecting the appropriate band set capacitor and the associated padder or padders. Band set capacitors A3C14 and A3C18 provide frequency set for band A, and are padded by capacitors A3C12, A3C13, A3C15, and A3C16, A3C17, respectively. Band set capacitor A3C9 provides frequency set for band C, and is padded by capacitors A3C8 and A3C17.

(2) Emitter Follower Driver, A3Q2. The output signal from the local oscillator is from the tap on transformer A3T2 and is coupled to the base of emitter follower-driver, transistor A3Q2, by capacitor A3C5. The function of transistor A3Q2 is primarily that of impedance converter buffer for matching and does not actually provide voltage gain to the system. Output at the emitter is coupled to the modulator driver, transistor A4Q9, in the restored frequency circuits, and to the local oscillator modulator driver, transistor A3Q3, through resistor A3R8.

(3) Modulator Driver, A3Q3. Transistor A3Q3, develops the amplified signal across transformer A3T1 primary. The secondary couples the output to the ring modulator. Coil A3L1 provides the decoupling from the 9.4 volt DC, regulated, supply.

d. I-f Amplifier and Metering

(1) Filter Driver, A2Q5. Transistor A2Q5, in common emitter configuration receives the output from the secondary of transformer A2T1 at the base. The emitter is partially bypassed across resistor A2R28 by capacitor A2C13. The resistance of resistor A2R27 not bypassed increases the input impedance of the circuit and develops a negative feedback to reduce distortion in the stage with consequent stabilization and high gain, approximately 14 dB. Bias for the stage is obtained from the voltage divider comprised of resistors, A2R24 and A2R25. The output of transistor A2Q5, through capacitor A2C12 drives the crystal bandpass filter A2FL2. Resistor A2R26 provides proper impedance matching to the 25 Hz bandpass filter A2FL2.

(2) Bandpass Filter, A2FL2. The 25 Hz crystal bandpass filter, has a center frequency of 250 kHz. The 3 dB and 60 dB points are approximately 25 Hz and 75 Hz. Input and output impedance is 2,000 ohms. The output is coupled to first i-f amplifier input, Module A4, for amplification.

(3) First I-f Amplifier, A4Q1 and A4Q2. Transistors A4Q1 and A4Q2, transformer A4T1, and associated coupling and biasing components amplify the 250 kHz i-f signal. Transistor A4Q1 is a buffer impedance converter providing impedance match from the 2,000 ohm output of bandpass filter A2FL2 to the common emitter amplifier, transistor A4Q2. The output voltage developed across transformer A4T1 in the collector circuit is coupled to the input of the second i-f amplifier.

(4) Second I-f Amplifier, A4Q3. The signal developed across transformer A4T1 is applied to the base of transistor A4Q3 in a common emitter configuration. Variable stage gain is provided by returning the emitter resistor A4R8 to ground through the CAL LEVEL control, variable resistor R101. The output signal is developed across transformer A4T2 in the collector circuit and coupled to the input of the third i-f amplifier and to the restored frequency buffer amplifier.

(5) Third I-f Amplifier, A4Q4. The signal developed across transformer A4T2 is applied to the base of transistor A4Q4 in a common emitter configuration. At this same point the i-f signal is coupled to the base of restored frequency, buffer amplifier, transistor A4Q10. Output of the third i-f amplifier is tuned by the primary of transformer A4T3 in the collector circuit, however, the output is capacitively coupled to the following stages. Output to the meter detector, diodes A4CR1 and A4CR2 is through capacitor A4C12. Output to the balanced modulator in the audio detector circuit is through capacitor A4C13 and series resistor A4R12.

(6) Meter Detector, A4CR1 and A4CR2. The 250 kHz signal is rectified by diodes A4CR1 and A4CR2 for application to the meter and to the RECORDER jack J2. Capacitors A4C14 and A4C15 provide the filtering for the rectified signal. Resistor A4R13 provides impedance matching to the meter and recorder circuits. Resistor R2 provides circuit balance in the metering circuit when a 100 ohm recorder is not connected to the RECORDER jack J2.

e. Audio Detector

(1) Balanced Modulator A4CR7 and A4CR8. The 250 kHz i-f signal applied to the balanced modulator is for combining with the 249 kHz frequency developed by the crystal oscillator, transistor A4Q13. The resultant 1,000 Hz signal is coupled to the audio amplifier input via the lowpass filter comprised of resistor A4R37 and capacitor A4C33, contacts on AUDIO IN jack J4, series capacitor C2, and AUDIO LEVEL control, variable resistor R102.

(2) Crystal Oscillator, A4Q13. The crystal oscillator develops a 249 kHz signal in a conventional circuit and couples the output to the modulator driver-phase splitter, transistor A4Q12.

(3) Modulator Driver, A4Q12. The output of the crystal oscillator is amplified and split in phase for proper drive to the balanced modulator, diodes A4CR7 and A4CR8.

f. Audio Amplifier

(1) First Audio Amplifier, A4Q5. The detected audio signal from the balanced modulator or the signal connected to AUDIO IN jack J4 is applied through capacitor C2, AUDIO LEVEL control, variable resistor R102, and capacitor A4C16 to the base of transistor A4Q5. AC feedback from the emitter circuit through capacitor A4C18 and resistor A4R14 to the base circuit effectively boot-straps the signal and increases the overall input impedance of the circuit. Output at the collector of the stage is coupled through capacitor A4C19 to the base of second Audio Amplifier, A4Q6.

(2) Second Audio Amplifier, A4Q6. The input signal applied to the base circuit of transistor A4Q6 is amplified and direct coupled at the collector to the audio output amplifier, transistor A4Q7 and A4Q8.

(3) Audio Output Amplifier, A4Q7 and A4Q8. Transistors A4Q7 and A4Q8 in a complimentary symmetry circuit receives the audio signal at the base of transistor A4Q8 and through diodes A4CR3 and A4CR4 to the base of transistor A4Q7. Diodes A4CR3 and A4CR4 furnish bias to the transistors by the voltage drop developed across the diodes. The transistors conducting on alternate half cycles of drive develop a single ended output for application to the speaker LS1 through contacts on HEADSET jack J5. Connecting a headset automatically disconnects the speaker.

g. Restored Frequency

(1) Modulator Driver, A4Q9. The local oscillator signal applied to the modulator driver, transistor A4Q9, is amplified and coupled through transformer A4T4 to the balanced modulator, diodes A4CR5 and A4CR6.

(2) Buffer, A4Q10. The buffer amplifier receives the i-f signal from the third i-f amplifier and amplifies this signal to the level for application to the balanced modulator, diodes A4CR5 and A4CR6.

(3) Balanced Modulator, A4CR5 and A4CR6. The signal at the junction of diodes A4CR5 and A4CR6 is the Local Oscillator plus or minus the I-f signal. The Local Oscillator minus the I-f signal is exactly the frequency of the tuned signal at the INPUT terminals. This output is applied to the lowpass filter module A6 input.

(4) Lowpass Filter Module A6. The lowpass filter is tuned to pass the frequencies below 180 kHz. The tuned input signal meter indication must

be above -20 dB for proper restored frequency operation. The output of lowpass filter module A6 is applied to the base of amplifier A4Q11 through capacitor A4C27.

(5) Amplifier, A4Q11. The restored frequency signal applied to the base circuit of transistor A4Q11 through capacitor A4C27 is amplified in the conventional common emitter voltage amplifier circuit. Output of the collector is coupled to the RESTORED FREQUENCY connector J3.

h. Calibrate Oscillator, A2Q3 and A2Q4

The calibrate oscillator develops the 2.5 kHz signal for application to the input circuit. Transistors A2Q3 and A2Q4 in a multivibrator circuit develop the signal when power is applied through contacts on INPUT SELECTOR switch S1. The output is then coupled via the front wafer on S1 to the ATTENUATOR module A1 input. The positive feedback path, to cause switching, and the frequency is determined by the emitter to emitter coupling. This is controlled by variable resistor A2R102 in the emitter coupling path. Output is from the collector of transistor A2Q3, across resistor A2R11. Output is coupled to the INPUT SELECTOR switch S1 through capacitor A2C4 and resistor A2R10, A2R101, and A2R9.

i. Power Supply

(1) AC Power Supply, A5CR1 and A5VR1. The AC power is transformed by A5T1 and rectified by A5CR1. The filter circuit is capacitor A5C1 and resistor A5R2. The output of filter is applied across the 15 volt Zener diode A5VR1. The output is applied to the voltage regulator A4Q14 and A4Q15 circuits and the trickle charge dropping resistor A5R1. The trickle charge is applied to battery BT1 through resistor A5R1 only when POWER switch S2 is in the AC (5 ma) position. In the BAT (65 ma) position of POWER switch S2, resistor A5R1 is shorted out by contacts on the front wafer of POWER switch S2 and a 65 milliamperes charging rate is applied to battery BT1. In this position removal of AC power automatically places the unit in operation from the internal battery BT1. The 15 volt DC output is applied to instrument circuits and the voltage regulator circuit through contacts on the front wafer of POWER switch S2.

(2) Voltage Regulator, A4Q14 and A4Q15. The 15 volt DC from the AC power supply or internal 12 to 15 volt battery BT1 is applied to the series voltage regulator, transistor A4Q15. The voltage at the emitter will rise until voltage reference, Zener diode A4VR1 conducts and turns transistor A4Q14, voltage amplifier, on. The conduction of transistor A4Q14 reduces the bias to transistor A4Q15 and reduces the output voltage at the emitter to 9.4 volts DC under varying load and input conditions. The regulated output is applied to circuits of the instrument.

(3) Battery, BT1. The Nickel-Cadmium, 12 to 15 volt, rechargeable battery provides battery operation when AC power is removed and the POWER switch

is in the BAT (65 ma) position. The BAT. TEST position, spring loaded, disconnects the charging circuits, but permits the instrument load to remain across battery. The meter is switched across the regulated 9.4 volt DC source. Indication of 0 dB ±0.5 dB shows that the battery is capable of operating the unit.

CHAPTER IV
MAINTENANCE

1. INTRODUCTION

This chapter covers the maintenance of the instrument. Before performing the procedures outlined in this chapter, a thorough understanding of the information covered in the preceding, Chapter III, Theory of Operation, is important.

2. TEST EQUIPMENT

The test equipment of table 3 is required to test and align the instrument, but it is not supplied.

Table 3. Test Equipment

EQUIPMENT	MANUFACTURER
Vacuum Tube Voltmeter (vtvm)	Triplett Model 850 or equivalent
Counter	Eldorado Model 1505B or equivalent
Signal Generator	Hewlett-Packard 651 or equivalent
AC Voltmeter (Ac vtvm)	Ballantine 303 or equivalent

3. MAINTENANCE

Maintenance involves two basic procedures: trouble localization and trouble isolation. Localization is the tracing of trouble to the circuit responsible for abnormal operation. Isolation means tracing the trouble to the defective component.

4. TROUBLE SHOOTING

a. Trouble Localization,

The localization of trouble is most easily accomplished by performing the trouble shooting procedure of Table 4, and noting test point locations shown in Figure 4. Table 3 lists the recommended test equipment.

CAUTION

Care must be exercised when using an ohmmeter in the testing of transistorized equipment. The application of ohmmeter test leads between emitter and base may damage the transistor due to reverse polarity voltage application from the meter. Check polarity of probes before testing if not known.

b. Trouble Isolation

The isolation of trouble to the defective part is most easily accomplished by performing voltage measurements as listed in Table 5. Reference to figure 3 should be made to determine lead configuration of the various semiconductor devices and typical trouble shooting techniques which are applicable to transistors. During the process of isolation using the voltage measurements continuous reference should be made to the component location illustrations, Figures 5, 6, 7, and 8, and the overall schematic diagram, Figure 11.

Table 4. Trouble Shooting Chart

CIRCUIT UNDER TEST	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
Power Supply	Rotate POWER switch to BAT. TEST	0 dB +0.5 dB	Recharge battery. Check circuits of Ni-Cad battery and AC power supply, meter M1, and regulator transistors A4Q14 and A4Q15.
Input Circuit Ring Modulator, I-f amplifier, Local Oscillator, and Calibrate Oscillator.	Calibrate instrument using internal Calibrate oscillator according to procedures of Chapter II, Paragraph 5.	0 dB indication	Trouble in one of the circuits under test. Proceed to next step.
Input Circuit	ATTENUATOR A1S1 set to -80 dB position. Apply 0.24 volt, 1 kHz signal to INPUT. Connect Ac vtvm to output terminal of filter A2FL1. Reference Figure 4 for connection point	Ac vtvm indicates .09 to .11 volts AC	Check INPUT SELECTOR S1, ATTENUATOR A1S1, transistors A2Q1, A2Q2 and filter A2FL1.
Ring Modulator	Apply 0.1 volts, 1 kHz signal to output terminal of filter A2FL1. Rotate TUNING control to approximately 1 kHz. Connect Ac vtvm terminated with a 50 ohm load to input of filter A2FL2. Reference Figure 4 for connection point.	Ac vtvm indicates .016 to .02 volts AC.	Check ring modulator, transistors A3Q1 thru A3Q3 and A2Q5.

Table 4. Trouble Shooting Chart (Cont)

CIRCUIT UNDER TEST	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
I-f Amplifier	Apply a 40 uV, 250 kHz signal to the input terminals of filter A2FL2. Tune signal generator for peak meter response. NOTE: The narrow passband of the filter will cause a very sharp tuning indication. Reference Figure 4 for connection point.	Meter on Voltmeter indicates 0 dB ±2 dB.	Check filter A2FL2, transistors A4Q1 thru A4Q4, and diodes A4CR1 and A4CR2.
Calibrate Oscillator A2Q3, A2Q4, INPUT SELECTOR S1, ATTENUATOR A1S1.	Set ATTENUATOR to -30 DB, INPUT SELECTOR to BRIDGE, BAND SELECTOR to band A, CAL LEVEL control to full cw position. Apply an external 2.5 kHz signal at -30 dB to INPUT terminals and peak meter by rotating TUNING control.	Meter indicates greater than 0 dB.	Check circuits under test. Trouble in Input circuit Ring Modulator.
Restored Frequency	ATTENUATOR set to -30 DB, INPUT SELECTOR set to BRIDGE position, BAND SELECTOR set to band A, set TUNING to 2.5 KHz dial indication. Connect Ac vtvm to RESTORED FREQUENCY jack.	Ac vtvm should indicate less than 0.03 volts.	Check transistors A4Q9 thru A4Q11, diodes A4CR5 and A4CR6 and module A6.
Restored Frequency	ATTENUATOR set to -30 DB, INPUT SELECTOR set to CAL, BAND SELECTOR set to band A, set TUNING to 2.5 KHz dial indication, CAL LEVEL for 0 dB meter indication. Connect Ac vtvm to RESTORED FREQUENCY jack.	Ac vtvm should indicate greater than 1 volt.	Check transistors A4Q9 thru A4Q11, diodes A4CR5 and A4CR6 and module A6.
Audio Amplifier	Connect a 1,000 Hz 0.1 volt in amplitude to the AUDIO IN jack. Rotate AUDIO LEVEL control fully clockwise.	High level 1,000 Hz audio tone in loudspeaker.	Check transistors A4Q5 thru A4Q8.
Audio Detector	ATTENUATOR set to -30 DB, INPUT SELECTOR set to CAL, BAND SELECTOR set to band A, set TUNING to 2.5 KHz CAL dial indication. Rotate AUDIO LEVEL control fully clockwise.	High level 1,000 Hz audio tone in loudspeaker.	Check transistors A4Q12 A4Q13, and diodes A4CR7 and A4CR8.

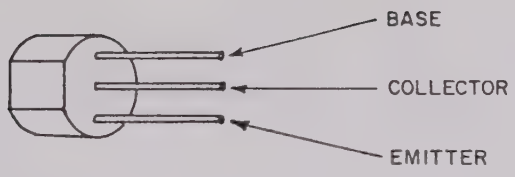
Table 5. Transistor Voltage Chart

Set instrument controls:

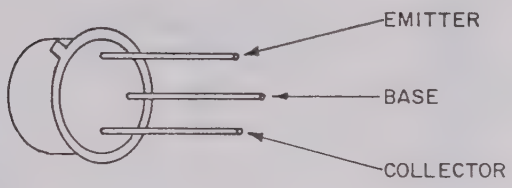
1. No signal input
2. CAL LEVEL fully cw
3. AUDIO LEVEL fully ccw
4. INPUT SELECTOR to CAL
5. POWER to BAT.

Readings taken with vtvm and should be ±10%.
All voltages positive with respect to chassis ground.

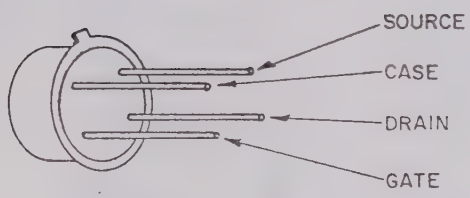
MODULE	TRANSISTOR	EMITTER	BASE	COLLECTOR
A2	Q1-F.E.T.	Source = 5.0	Gate = 2.2	Drain = 8.5
	Q2	4.4	5.0	8.5
	Q3	5.7	5.6	8.5
	Q4	3.7	3.7	5.6
	Q5	0.78	1.42	5.2
A3	Q1	2.4	2.9	7.2
	Q2	1.6	2.2	9.0
	Q3	1.0	1.6	9.0
A4	Q1	1.1	1.70	9.4
	Q2	0.5	1.10	9.4
	Q3	1.0	1.70	9.4
	Q4	0.8	1.40	9.0
	Q5	0.4	1.10	6.5
	Q6	0.33	0.96	7.5
	Q7	8.0	8.60	13.0
	Q8	8.0	7.40	0.0
	Q9	0.90	1.50	8.0
	Q10	0.82	1.50	8.0
	Q11	0.85	1.50	5.0
	Q12	1.05	1.50	7.7
	Q13	1.10	1.70	7.4
	Q14	0	0.67	10.2
	Q15	13.0	10.20	9.40
A5	+ Terminal of CR1	+32 V dc with POWER switch in AC		
	+ Terminal of VR1	+15 V dc with POWER switch in AC		



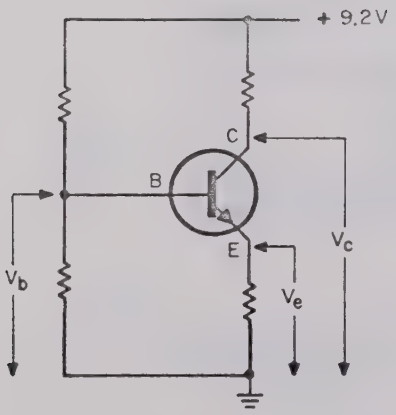
RC3710, 2N3706, 2N3707, AND 2N3702 TYPES



2N3053 TYPE



2N3684 F.E.T. TYPE



WHERE: B = BASE, C = COLLECTOR, E = EMITTER and V_b = BASE VOLTAGE, V_c = COLLECTOR VOLTAGE, V_e = EMITTER VOLTAGE

1. IF V_e IS LESS THAN VALUE SHOWN IN TABLE 4, AND V_b IS NORMAL, TRANSISTOR IS OPEN.
2. IF Ve IS GREATER THAN INDICATED, TRANSISTOR IS SHORTED.
3. THE NORMAL VOLTAGE BETWEEN BASE AND EMITTER OF AN AMPLIFIER WITH SILICON TRANSISTORS IS BETWEEN 0.5 AND 0.7 VOLTS.

Figure 3. Transistor Terminations and Trouble Shooting

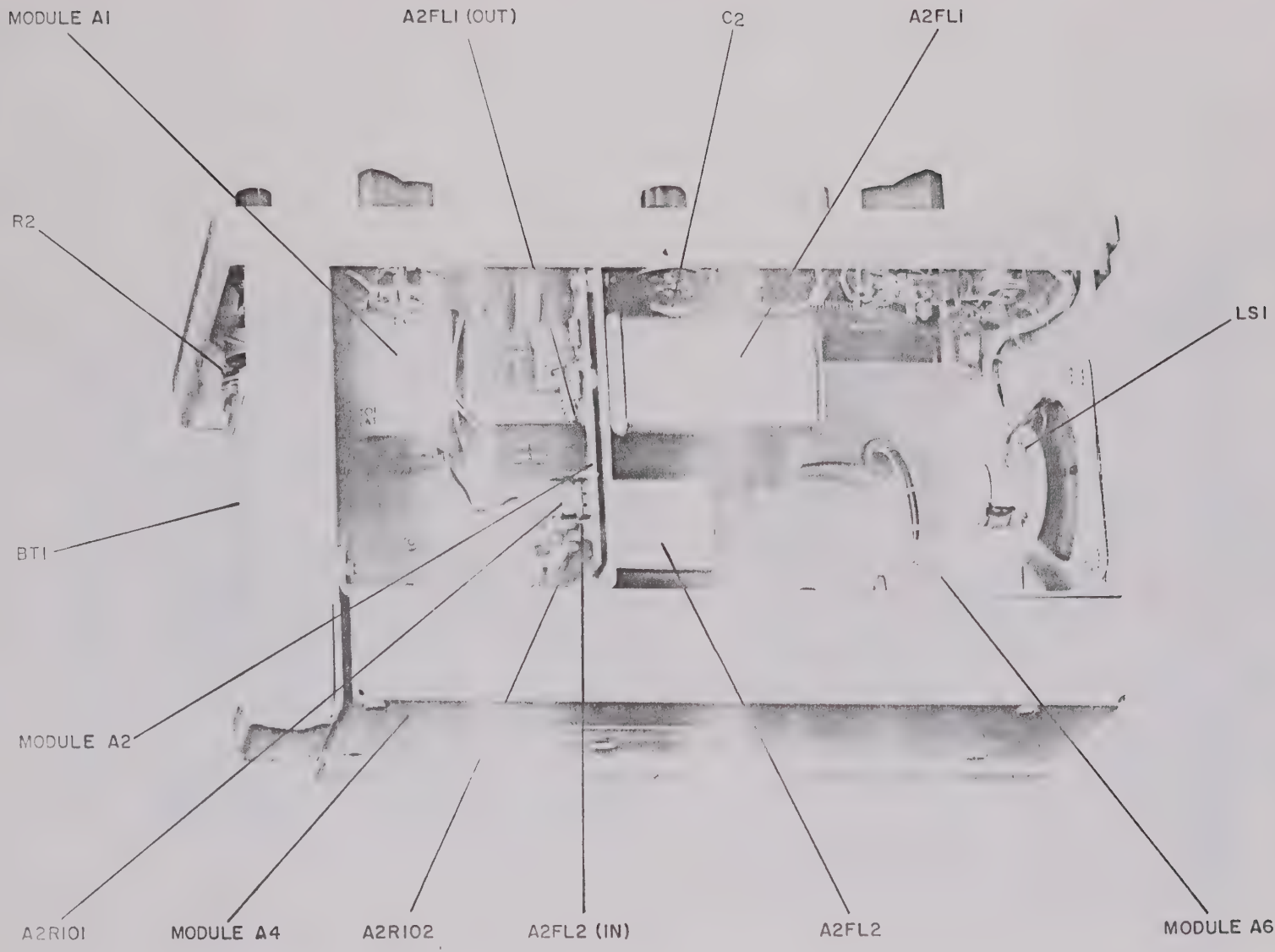


Figure 4. Component and Test Point Locations

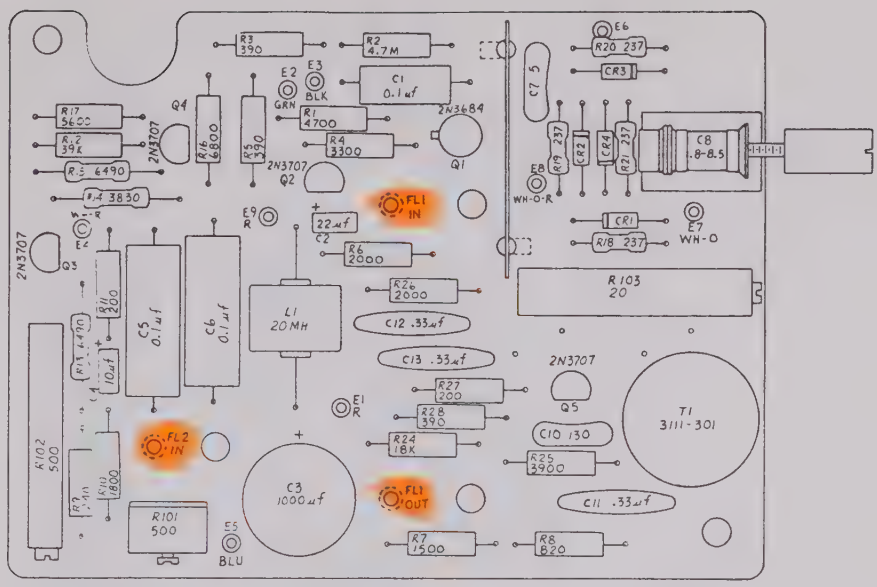


Figure 5. Module A2 Circuit Board

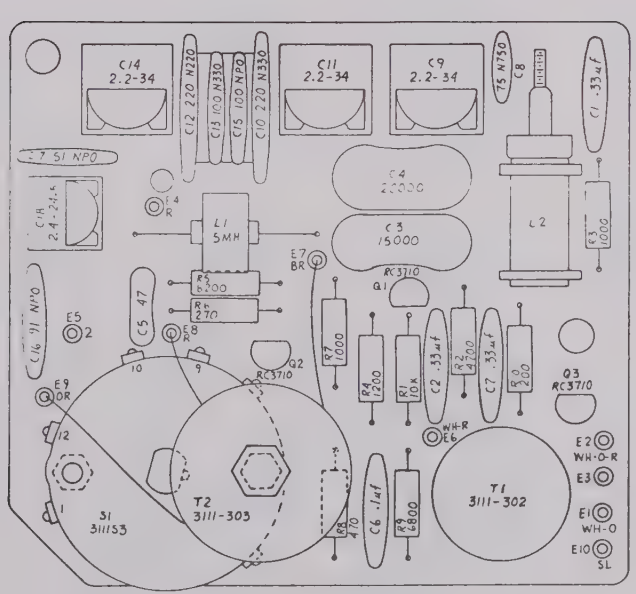


Figure 6. Module A3 Circuit Board

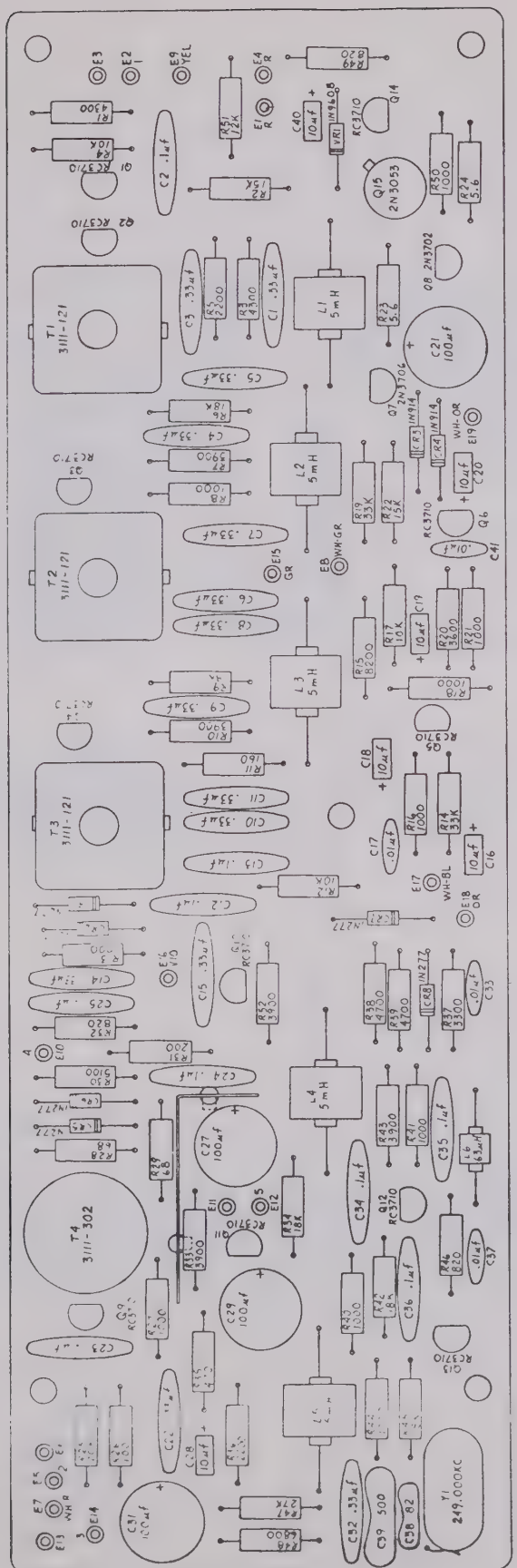


Figure 7. Module A4 Circuit Board

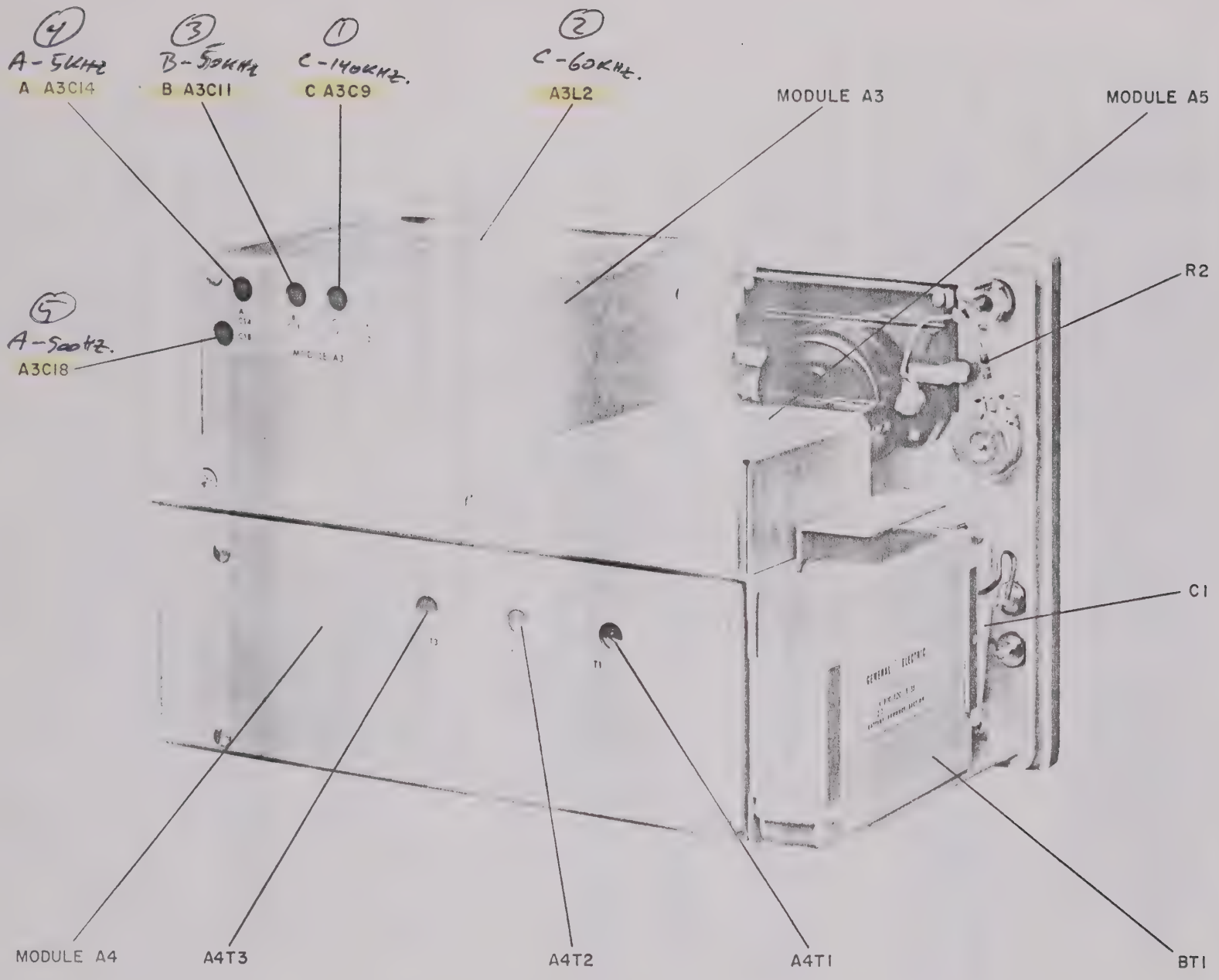


Figure 8. Component Location

5. PARTS REPLACEMENT

Replacement of component parts in the instrument does not entail special procedures. Care must be exercised that the part to be replaced is selected by reference to the Parts List, Chapter V. References to Figures 4, 5, 6, 7, and 8, will aid in location and identification of component parts. Refer to the following paragraphs and complete Alignment procedures after repair or part replacement is completed.

6. ALIGNMENT

Under normal operating conditions and usage of the instrument, alignment should not be performed as routine maintenance. However, if parts replacement or repairs are made, alignment must be performed. Refer to Figures 4 and 8 for location of adjustment points referred to in subsequent paragraphs, and Table 3 for recommended test equipment.

a. Calibrate Oscillator

Calibration is accomplished by comparing the calibration oscillator frequency and output level to a known external source. The equipment should be connected as shown in Figure 9 before proceeding.

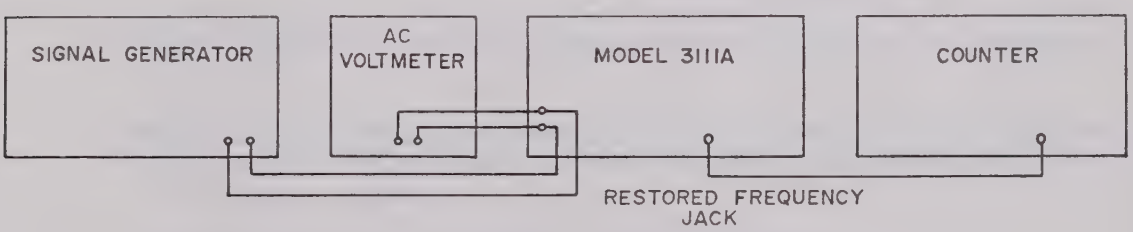


Figure 9. Test Setup for Calibrate Oscillator Alignment

(1) Set instrument switches and controls:

Switch/Control	Position
INPUT SELECTOR	BRIDGE
ATTENUATOR	-30 DB
BAND SELECTOR	A
TUNING	2.5 kHz CAL on FREQUENCY dial

(2) Adjust signal generator frequency to 2.5 kHz.

(3) Adjust signal generator output to -30 dB (24.5 mV) level.

(4) Adjust TUNING control for maximum meter indication.

(5) Adjust CAL LEVEL for 0 dB meter indication.

(6) Set INPUT SELECTOR to CAL position.

(7) Adjust TUNING control for maximum meter indication.

(8) Adjust R101 on Module A2 for 0 dB meter indication.

(9) Adjust R102 on Module A2 for 2.5 kHz ±1.0 Hz on counter.

b. I-f Amplifier

The alignment of the 250 kHz i-f amplifier Module A4 is performed by using the internal calibrate oscillator as a signal source. Proceed as follows:

(1) Set instrument switches and controls:

Switch/Control	Position
INPUT SELECTOR	CAL
ATTENUATOR	-30 DB
BAND SELECTOR	A
TUNING	Adjust for maximum meter indication

(2) Adjust ATTENUATOR and CAL LEVEL so meter indication is between -10 dB and 0 dB.

(3) Adjust T1, T2, and T3 on Module A4 with a non-metalic tuning tool for maximum meter indication. Adjust CAL LEVEL and ATTENUATOR to keep meter indication on scale.

(4) Recalibrate unit per Chapter II, Paragraph 5.

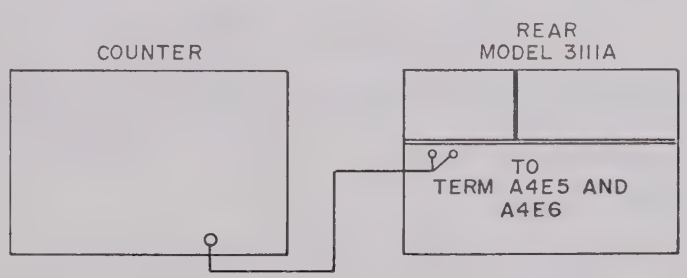


Figure 10. Test Setup, Local Oscillator Alignment

c. Local Oscillator

Alignment must be done in sequence outlined below with oscillator cover installed.

(1) Connect counter to pin A4E5 and ground pin A4E6, on Module A4.

(2) Align red cursor with notch in top of FREQUENCY dial bezel opening.

(a) Set BAND SELECTOR to band C.

(b) Set TUNING to exactly 140 kHz on FREQUENCY dial.

(c) Adjust A3C9 for 390,000 Hz on counter.

(d) Set TUNING to exactly 60 kHz on FREQUENCY dial.

(e) Adjust A3L2 for 310,000 Hz on counter.

(f) Repeat steps (b) through (e) until counter indication of 310,000 Hz is shown, ±10 Hz.

(3) Band B alignment

(a) Set BAND SELECTOR to band B.

(b) Set TUNING to exactly 50 kHz on FREQUENCY dial.

(c) Adjust A3C11 for 300,000 Hz on counter

(4) Band A alignment

(a) Set BAND SELECTOR to band A.

(b) Set TUNING to exactly 5 kHz on FREQUENCY dial.

(c) Adjust A3C14 for 255,000 Hz on counter.

(d) Set TUNING to exactly 500 Hz on FREQUENCY dial.

(e) Adjust A3C18 for 250,~~000~~ 500 Hz on counter.

(f) Repeat steps (b) through (e) until counter indication of 255,000 is shown, ±3 Hz.

CHAPTER V
PARTS LIST

1. HOW TO ORDER PARTS

When ordering parts, always include:

a. Name, Model and serial number of the instrument.
b. Module and reference designation.
c. Part number
d. Description.

Order parts from:

RYCOM INSTRUMENTS
9351 East 59th Street
Raytown, Missouri 64133 Telephone 816-353-2100

NOTE: $10.00 minimum on all orders.

2. LIST OF MANUFACTURERS.

Code is listed in parts list under MFR.

Code	Name and Address
01121	Allen-Bradley Co. 1201 S. 2nd St. Milwaukee, Wisc. 53204
01295	Texas Instruments, Inc. Semiconductor-Components Div. 13500 N. Central Expressway Dallas, Tex. 75231
03508	General Electric Co. Semi-Conductor Products Dept. Electronics Park Syracuse, N. Y. 13201
03877	Transitron Electronic Corp. 168-186 Albion St. Wakefield, Mass. 01880
04713	Motorola Semiconductor Products, Inc. 5005 E. McDowell Rd.
05397	Union Carbide Corp., Lind Div. Kemet Dept. Cleveland, Ohio
05844	Callins Industries Inc. P.O. Box C Greenfield Tenn. 38230
07109	Oaktron Industries P.O. Box 86 Monroe, Wisc. 53566
09408	StarTronics Connectors Electronic Products Div. E G and G Inc. Moulton and Monroe Sts. Georgetown, Mass. 01830
11237	CTS Keene, Inc. 3230 Riverside Ave. Paso Robles, Calif. 93446
13571	Electronic Research Corp. 10005 W. 75th Overland Park, Kans. 66204
14752	Electro Cube 1710 S. Del Mar Ave. San Gabriel, Calif. 91776

Code	Name and Address
18410	RYCOM INSTRUMENTS RAILWAY COMMUNICATIONS, INC. 9351 E. 59th St. Raytown, Mo. 64133
22229	Solitron Devices Inc. 8808 Balboa Ave. San Diego, Calif. 92123
22701	Bestran Corp. Dilectron Div. 2669 S. Myrtle Ave. Monrovia, Calif. 91016
29309	Richey Electronics, Inc. 1307 Dickerson Rd. Nashville, Tenn. 37213
32463	CTS of Brownsville, Inc. 1100 Roosevelt St. Brownsville, Tex. 78520
44655	Ohmite Mfg. Co. 3601 W. Howard St. Skokie, Ill. 60076
56289	Sprague Electric Co. North Adams, Mass. 01247
70903	Beldon Corp. 415 S. Kilpatrick Chicago, Ill. 60644
72136	Electro Motive Mfg. Co., Inc. South Park and John Streets Willimantic, Conn. 06226
72982	Erie Technological Products Inc. 644 W. 12th St. Erie, Pa. 16512
74970	E. F. Johnson Co. 299 10th Ave. S.W. Waseca, Minn. 56093
76493	J. W. Miller Co. P.O. Box 5825 19070 Reyes Ave. Compton, Calif. 90024
79089	RCA Corp, Receiving Tube Div. 415 S. 5th St. Harrison N. J. 07029
81071	Shauer Mfg. Corp. 4500 Alpine Cincinnati, Ohio 45242
81073	Grayhill, Inc. 561 Hillgrove Ave. La Grange, Ill. 60630
82389	Switchcraft, Inc. 5555 N. Elston Ave. Chicago, Ill. 60646
84048	IRC, Division of TRW St Petersburg Plant 2801 72nd St. N St Petersburg, Fla. 33702
84411	TRW, Capacitor Division 112 W. First St. Ogallala, Nebr. 69153
84970	Sarkes Tarzian Inc. Broadcast Equipment Div. E Hillside Dr. Bloomington, Ind. 47401
87930	Tower Mfg. Corp. 158 Pine St. Providence, R. I. 02903
99848	Wilco Corp. 4030 W. 10th St. P.O. Box 22248 Indianapolis, Ind. 46222

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	PARTS LOCATED ON FRONT PANEL OR CHASSIS			
BT1	Battery, nickel-cadmium, rechargeable, 12 volt, 1 amp-hr, with wire lead type connections. Serial No. 101-149	41B001KD07	18410	1
BT1	Battery, nickel-cadmium, rechargeable 12 volt, 1 amp-hr, with terminal post type connection. Serial No. 150 up. NOTE: Order Battery No. 3067 for replacement on all units.	41B001KD20 or 10-S-113 or 3067	18410	1
C1	Cap, 5 uF ±20%, 200 wvdc, mylar	X663F50502W	84411	1
C2	Cap, 10 uF (-10%, +100%), 15 wvdc dry electrolytic	30D106G015 BA2	56289	1
C3	Cap, var, air, 11.6-202 pF	167-152-10	18410	1
E1	Binding Post, red	29-1-R	81073	1
E2	Binding Post, black	29-1-B	81073	1
	Mounting Plate, black	29B11-1	81073	1
J1	Connector, electrical power	H1061-IG	87930	1
J2	Jack, headset	L-12A	82389	3
J3	Connector, BNC	31-102	09408	1
J4	Jack, same as J2			
J5	Jack, same as J2			
LS1	Loudspeaker	3A1415	07109	1
M1	Meter, 0-1 mA, 100 ohms dc res.	3005-42	18410	1
R1	Res, 604 ohms ±1%. 1/4 W at 125°C, metal film	RY65D6040F	18410	1
R2	Res, 100 ohms ±5%, 1/2 W, carbon	EB1015	01121	1
R3	Res, 39,000 ohms ±5%, 1/2 W, carbon	EB3935	01121	1
R101	Res, var, 5000 ohms ±30%, 1/2 W, comp	JF7539	34263	1
R102	Res, var, 25 k ohms ±30%, 1/2 W, comp	303791	11237	1
S1	Switch, rotary, 2-pole, 3-pos.	3111S1	18410	1
S2	Switch, rotary, 3-pole, 4-pos.	3131S7	18410	1
WA1	Cord Assy, power	17258S	70903	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A1			
A1R1	Res, 100 k ohms ±1%, 1/8 W at 70°C metal film	RY55D1003F	18410	2
A1R2	Res, 316 ohms ±1%, 1/8 W at 70°C metal film	RY55D3160F	18410	2
A1R3	Res, 100 k ohms, same as A1R1			
A1R4	Res, 316 ohms, same as A1R2			
A1R5	Res, 68,100 ohms ±1%, 1/8 W at 70°C metal film	RY55D6812F	18410	1
A1R6	Res, 21,500 ohms ±1%, 1/8 W at 70°C metal film	RY55D2152F	18410	1
A1R7	Res, 6810 ohms ±1%, 1/8 W at 70°C metal film	RY55D6811F	18410	1
A1R8	Res, 2150 ohms ±1%, 1/8 W at 70°C metal film	RY55D2151F	18410	1
A1R9	Res, 1000 ohms ±1%, 1/8 W at 70°C metal film	RY55D1001F	18410	1
A1S1	Switch, rotary, 3-pole, 11-pos.	3111S2	18410	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A2			
A2C1	Cap, 0.1 uF ±10%, 200 wvdc, mylar	210B1C104K	14752	1
A2C2	Cap, 22 uF ±20%, 6 wvdc, tantalum	K22W6	05397	1
A2C3	Cap, 1000 uF (-10%, +100%), 10 wvdc dry electrolytic	24-625-1000 -10-8PC	29309	1
A2C4	Cap, 10 uF ±20%, 10 wvdc, tantalum	K10W10	05397	1
A2C5	Cap, 2000 pF ±5%, 500 wvdc, silver mica Serial No. 101-329	DM19E202J	72136	1
A2C5A	Cap, 0.1 uF ±5%, 100 wvdc, polysulphone Serial No. 330 up.	AC26B104J	03508	2
A2C6	Cap, 0.047 uF ±5%, 100 wvdc, polycarbonate Serial No. 101-329	AA12A473	05308	1
A2C6A	Cap, 0.1 uF, same as A2C5A Serial No. 330 up.			
A2C7	Cap, 5 pF ±0.5%, 500 wvdc, silver mica	DM15C050D	72136	1
A2C8	Cap, var, piston, .8-8.5 pF	3111A2C8	18410	1
A2C9	NOT USED			
A2C10	Cap, 130 pF ±5%, 500 wvdc, silver mica	DM15E131J	72136	1
A2C11	Cap, 0.33 uF ±20%, 12 wvdc, ceramic	5645000Y5F00 334M	72982	3
A2C12	Cap, 0.33 uF, same as A2C11			
A2C13	Cap, 0.33 uF, same as A2C11			
A2CR1-4	Diode, silicon, matched quad	RY3604	18410	1
A2FL1	Filter, lowpass	3111FL1	18410	1
A2FL2	Filter, bandpass, 250 kHz center frequency, 25 Hz bandwidth	3111FL2	18410	1
A2L1	Coil, rf, 20 mH	U203	99848	1
A2Q1	Transistor, FET	2N3684	22229	1
A2Q2	Transistor, silicon, NPN	2N3707	01295	4
A2Q3	Transistor, same as A2Q2			
A2Q4	Transistor, same as A2Q2			
A2Q5	Transistor, same as A2Q2			
A2R1	Res, 4700 ohms ±5%, 1/2 W, carbon	EB4725	01121	1
A2R2	Res, 4.7 megohms ±5%, 1/2 W, carbon	EB4755	01121	1
A2R3	Res, 390 ohms ±5%, 1/2 W, carbon	EB3915	01121	3
A2R4	Res, 3300 ohms ±5%, 1/2 W, carbon	EB3325	01121	1
A2R5	Res, 390 ohms, same as A2R3			
A2R6	Res, 2000 ohms ±5%, 1/2 W, carbon	EB2025	01121	2
A2R7	Res, 1500 ohms ±5%, 1/2 W, carbon	EB1525	01121	1
A2R8	Res, 820 ohms ±5%, 1/2 W, carbon	EB8215	01121	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A2 (Cont)			
A2R9	Res, 240 ohms ±5%, 1/2 W, carbon	EB2415	01121	1
A2R10	Res, 1800 ohms ±5%, 1/2 W, carbon	EB1825	01121	1
A2R11	Res, 200 ohms ±5%, 1/2 W, carbon	EB2015	01121	1
A2R12	Res, 39,000 ohms ±5%, 1/2 W, carbon	EB3935	01121	1
A2R13	Res, 6490 ohms ±1%, 1/4 W at 70°C metal film	RY60D6491F	18410	2
A2R14	Res, 3830 ohms ±1%, 1/4 W at 70°C metal film	RY60D3831F	18410	1
A2R15	Res, 6490 ohms, same as A2R13			
A2R16	Res, 6800 ohms ±5%, 1/2 W, carbon	EB6825	01121	1
A2R17	Res, 5600 ohms ±5%, 1/2 W, carbon	EB5625	01121	1
A2R18	Res, 237 ohms ±1%, 1/4 W at 125°C metal film	RY55D2370F	18410	4
A2R19	Res, 237 ohms, same as A2R18			
A2R20	Res, 237 ohms, same as A2R18			
A2R21	Res, 237 ohms, same as A2R18			
A2R22	Res, 13 ohms ±1%, 1/4 W at 70°C metal film A2R22 used on Serial No. 101-249 only	RY60D13R0F	18410	2
A2R23	Res, 13 ohms, same as A2R22 A2R23 used on Serial No. 101-249 only			
A2R24	Res, 18,000 ohms ±5%, 1/2 W, carbon	EB1835	01121	1
A2R25	Res, 3900 ohms ±5%, 1/2 W, carbon	EB3925	01121	1
A2R26	Res, 2000 ohms, same as A2R6			
A2R27	Res, 200 ohms, same as A2R11			
A2R28	Res, 390 ohms, same as A2R3			
A2R101	Res, var, 500 ohms ±20%, 1/8 W, comp	220S501B	11237	1
A2R102	Res, var, 500 ohms ±10%, 1/2 W, comp	450-10	84048	1
A2R103	Res, var, 100 ohms ±10%, 1/2 W, wire wound Serial No. 101-249. NOTE: replace with A2R103A and delete A2R22 and A2R23	RH101U	01121	1
A2R103A	Res, var, 20 ohms ±15%, 1/10 W, wire wound. Serial No. 250 up.	3111-131	18410	1
A2T1	Transformer rf,	3111-301	18410	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A3			
A3C1	Cap, 0.33 uF ±20%, 12 wvdc, ceramic	5645000Y5F00 334M	72982	3
A3C2	Cap, 0.33 uF, same as A3C1			
A3C3	Cap, 15,000 pF ±5%, 300 wvdc, silver mica	DM30F153J	72136	1
A3C4	Cap, 20,000 pF ±5%, 300 wvdc, silver mica	DM30F203J	72136	1
A3C5	Cap, 47 pF ±5%, 500 wvdc, silver mica	DM15E470J	72136	1
A3C6	Cap, 0.1 uF (-20%, +80%), 25 wvdc ceramic	5815000Y5U00 104Z	72982	1
A3C7	Cap, 0.33 uF, same as A3C1			
A3C8	Cap, 75 pF ±5%, 500 wvdc, N750, ceramic	0851000U2J00 750J	72982	1
A3C9	Cap, var, air, 2.2-34 pF	193-10-5	74970	3
A3C10	Cap, 220 pF ±5%, 1000 wvdc, N330 ceramic	Type TC	22701	1
A3C11	Cap, 2.2-34 pF, same as A3C9			
A3C12	Cap, 220 pF ±5%, 1000 wvdc, N220 ceramic	Type TC	22701	1
A3C13	Cap, 100 pF ±5%, 1000 wvdc, N330, ceramic Temperature coefficient selected as required.	Type TC	22701	1
A3C14	Cap, 2.2-34 pF, same as A3C9			
A3C15	Cap, 100 pF ±5%, 500 wvdc, NPO, ceramic	0811000C0G00 101J	72982	1
A3C16	Cap, 91 pF ±5%, 1000 wvdc, NPO, ceramic	Type TC	22701	1
A3C17	Cap, 51 pF ±5%, 1000 wvdc, NPO, ceramic	Type TC	22701	1
A3C18	Cap, var, 2.4-24.5 pF	189-509-5	74970	1
A3L1	Coil, rf, 5 mH	U502	99848	1
A3L2	Coil, rf, var, 30-60 uH	3111A3L2	18410	1
A3Q1	Transistor, silicon, NPN	RC3710	18410	3
A3Q2	Transistor, same as A3Q1			
A3Q3	Transistor, same as A3Q1			
A3R1	Res, 10,000 ohms ±5%, 1/2 W, carbon	EB1035	01121	1
A3R2	Res, 4700 ohms ±5%, 1/2 W, carbon	EB4725	01121	1
A3R3	Res, 1000 ohms ±5%, 1/2 W, carbon	EB1025	01121	2
A3R4	Res, 1200 ohms ±5%, 1/2 W, carbon	EB1225	01121	1
A3R5	Res, 8200 ohms ±5%, 1/2 W, carbon	EB8225	01121	1
A3R6	Res, 2700 ohms ±5%, 1/2 W, carbon	EB2725	01121	1
A3R7	Res, 1000 ohms, same as A3R3			
A3R8	Res, 470 ohms ±5%, 1/2 W, carbon	EB4715	01121	1
A3R9	Res, 6800 ohms ±5%, 1/2 W, carbon	EB6825	01121	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A3 (Cont)			
A3R10	Res, 200 ohms ±5%, 1/2 W, carbon	EB2015	01121	1
A3S1	Switch, rotary, 1-pole, 3-pos.	3111S3	18410	1
A3T1	Transformer, rf,	3111-302	18410	1
A3T2	Transformer, rf	3111-303	18410	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY ASSY
	MODULE A4			
A4C1	Cap, 0.33 uF ±20%, 12 wvdc, ceramic	5645000Y5F00 334M	72982	14
A4C2	Cap, 0.1 uF (-20%, +80%), 25 wvdc, ceramic	5815000Y5U00 104Z	72982	9
A4C3	Cap, 0.33 uF, same as A4C1			
A4C4	Cap, 0.33 uF, same as A4C1			
A4C5	Cap, 0.33 uF, same as A4C1			
A4C6	Cap, 0.33 uF, same as A4C1			
A4C7	Cap, 0.33 uF, same as A4C1			
A4C8	Cap, 0.33 uF, same as A4C1			
A4C9	Cap, 0.33 uF, same as A4C1			
A4C10	Cap, 0.33 uF, same as A4C1			
A4C11	Cap, 0.33 uF, same as A4C1			
A4C12	Cap, 0.1 uF, same as A4C2			
A4C13	Cap, 0.1 uF, same as A4C2			
A4C14	Cap, 0.33 uF, same as A4C1			
A4C15	Cap, 0.33 uF, same as A4C1			
A4C16	Cap, 10 uF ±20%, 10 wvdc, tantalum	K10W10	05397	6
A4C17	Cap, 0.01 uF ±20%, 100 wvdc, ceramic NOTE: <u>All 0.01 uF capacitors</u>; Serial No. 101-329 used 500 wvdc units with .375 lead spacing.	0805024Z5U00 103M	72982	2
A4C18	Cap, 10 uF, same as A4C16			
A4C19	Cap, 10 uF, same as A4C16			
A4C20	Cap, 10 uF, same as A4C16			
A4C21	Cap, 100 uF (-10%, +100%), 30 wvdc electrolytic	11-65PSS100 -30S	05844	4
A4C22	Cap, 0.33 uF, same as A4C1			
A4C23	Cap, 0.1 uF, same as A4C2			
A4C24	Cap, 0.1 uF, same as A4C2			
A4C25	Cap, 0.1 uF, same as A4C2			
A4C26	NOT USED			
A4C27	Cap, 100 uF, same as A4C21			
A4C28	Cap, 10 uF, same as A4C16			
A4C29	Cap, 100 uF, same as A4C21			
A4C30	NOT USED			
A4C31	Cap, 100 uF, same as A4C21			
A4C32	Cap, 0.33 uF, same as A4C1			
A4C33	Cap, 0.01 uF, same as A4C17			
A4C34	Cap, 0.1 uF, same as A4C2			
A4C35	Cap, 0.1 uF, same as A4C2			
A4C36	Cap, 0.1 uF, same as A4C2			
A4C37	Cap, 0.01 uF, same as A4C17			
A4C38	Cap, 82 pF ±5%, 500 wvdc, silver mica	DM15E820J	72136	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A4 (Cont)			
A4C39	Cap, 500 pF ±5%, 500 wvdc, silver mica	DM19E501J	72136	1
A4C40	Cap, 10 uF, same as A4C16			
A4C41	Cap, 0.01 uF, same as A4C17 Serial No. 330 up. (Not used on Serial No. 101-329).			
A4CR1	Diode, Germanium	1N277	03877	6
A4CR2	Diode, same as A4CR1			
A4CR3	Diode, silicon	1N914	01295	2
A4CR4	Diode, same as A4CR3			
A4CR5	Diode, same as A4CR1			
A4CR6	Diode, same as A4CR1			
A4CR7	Diode, same as A4CR1			
A4CR8	Diode, same as A4CR1			
A4L1	Coil, rf, 5 mH	U502	99848	5
A4L2	Coil, rf, 5 mH, same as A4L1			
A4L3	Coil, rf, 5 mH, same as A4L1			
A4L4	Coil, rf, 5 mH, same as A4L1			
A4L5	Coil, rf, 5 mH, same as A4L1			
A4L6	Coil, rf, 63 uH	3063-12	99848	1
A4Q1	Transistor, silicon, NPN	RC3710	18410	12
A4Q2	Transistor, same as A4Q1			
A4Q3	Transistor, same as A4Q1			
A4Q4	Transistor, same as A4Q1			
A4Q5	Transistor, same as A4Q1			
A4Q6	Transistor, same as A4Q1			
A4Q7	Transistor, silicon, NPN	2N3706	01295	1
A4Q8	Transistor, silicon, PNP	2N3702	01295	1
A4Q9	Transistor, same as A4Q1			
A4Q10	Transistor, same as A4Q1			
A4Q11	Transistor, same as A4Q1			
A4Q12	Transistor, same as A4Q1			
A4Q13	Transistor, same as A4Q1			
A4Q14	Transistor, same as A4Q1			
A4Q15	Transistor, silicon, NPN	2N3053	79089	1
A4R1	Res, 4300 ohms ±5%, 1/2 W, carbon	EB4325	01121	1
A4R2	Res, 18,000 ohms ±5%, 1/2 W, carbon Serial No. 101-123	EB1835	01121	5
A4R2A	Res, 15,000 ohms ±5%, 1/2 W, carbon Serial 124 up.	EB1535	01121	2
A4R3	Res, 3900 ohms ±5%, 1/2 W, carbon	EB3925	01121	6

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A4 (Cont)			
A4R4	Res, 10,000 ohms ±5%, 1/2 W, carbon	EB1035	01121	3
A4R5	Res, 2200 ohms ±5%, 1/2 W, carbon NOTE: Value selected to give proper CAL LEVEL range	EB2225	01121	2
A4R6	Res, 18,000 ohms, same as A4R2			
A4R7	Res, 3900 ohms, same as A4R3			
A4R8	Res, 1000 ohms ±5%, 1/2 W, carbon	EB1025	01121	10
A4R9	Res, 18,000 ohms, same as A4R2			
A4R10	Res, 3900 ohms, same as A4R3			
A4R11	Res, 160 ohms ±5%, 1/2 W, carbon	EB1615	01121	1
A4R12	Res, 10,000 ohms, same as A4R4			
A4R13	Res, 1000 ohms, same as A4R8			
A4R14	Res, 33,000 ohms ±5%, 1/2 W, carbon	EB3335	01121	1
A4R15	Res, 8200 ohms ±5%, 1/2 W, carbon	EB8225	01121	1
A4R16	Res, 1000 ohms, same as A4R8			
A4R17	Res, 10,000 ohms, same as A4R4			
A4R18	Res, 1000 ohms, same as A4R8			
A4R19	Res, 33,000 ohms, same as A4R14			
A4R20	Res, 36,000 ohms ±5%, 1/2 W, carbon	EB3635	01121	1
A4R12	Res, 1000 ohms, same as A4R8			
A4R22	Res, 15,000 ohms, same as A4R2A			
A4R23	Res, 5.6 ohms ±5%, 1/2 W, carbon	EB56G5	01121	2
A4R24	Res, 5.6 ohms, same as A4R23			
A4R25	Res, 20,000 ohms ±5%, 1/2 W, carbon	EB2035	01121	1
A4R26	Res, 100 ohms ±5%, 1/2 W, carbon	EB1015	01121	1
A4R27	Res, 1000 ohms, same as A4R8			
A4R28	Res, 68 ohms ±5%, 1/2 W, carbon	EB6805	01121	2
A4R29	Res, 68 ohms, same as A4R28			
A4R30	Res, 5100 ohms ±5%, 1/2 W, carbon	EB5125	01121	1
A4R31	Res, 200 ohms ±5%, 1/2 W, carbon	EB2015	01121	1
A4R32	Res, 820 ohms ±5%, 1/2 W, carbon	EB8215	01121	3
A4R33	Res, 3900 ohms, same as A4R3			
A4R34	Res, 18,000 ohms, same as A4R2			
A4R35	Res, 470 ohms ±5%, 1/2 W, carbon	EB4715	01121	1
A4R36	Res, 2200 ohms, same as A4R5			
A4R37	Res, 3300 ohms ±5%, 1/2 W, carbon	EB3325	01121	1
A4R38	Res, 4700 ohms ±5%, 1/2 W, carbon	EB4725	01121	2
A4R39	Res, 4700 ohms, same as A4R38			
A4R40	Res, 1000 ohms, same as A4R8			
A4R41	Res, 1000 ohms, same as A4R8			
A4R42	Res, 18,000 ohms, same as A4R2			
A4R43	Res, 3900 ohms, same as A4R3			
A4R44	Res, 1000 ohms, same as A4R8			
A4R45	Res, 18,000 ohms, same as A4R2			
A4R46	Res, 820 ohms, same as A4R32			
A4R47	Res, 27,000 ohms ±5%, 1/2 W, carbon	EB2735	01121	1
A4R48	Res, 6800 ohms ±5%, 1/2 W, carbon	EB6825	01121	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A4 (Cont)			
A4R50	Res, 1000 ohms, same as A4R8			
A4R51	Res, 12,000 ohms ±5%, 1/2 W, carbon	EB1235	01121	1
A4R52	Res, 3900 ohms, same as A4R3			
A4T1	Transformer, I-f	3111-121	18410	3
A4T2	Transformer, same as A4T1			
A4T3	Transformer, same as A4T1			
A4T4	Transformer, rf	3111-302	18410	1
A4VR1	Diode, Zener, 9.1 volt	1N960B	01295	1
		or		
		SC9.1	81071	1
A4Y1	Crystal, Quartz, 249 kHz	CR46A/U	13571	1

PARTS LIST

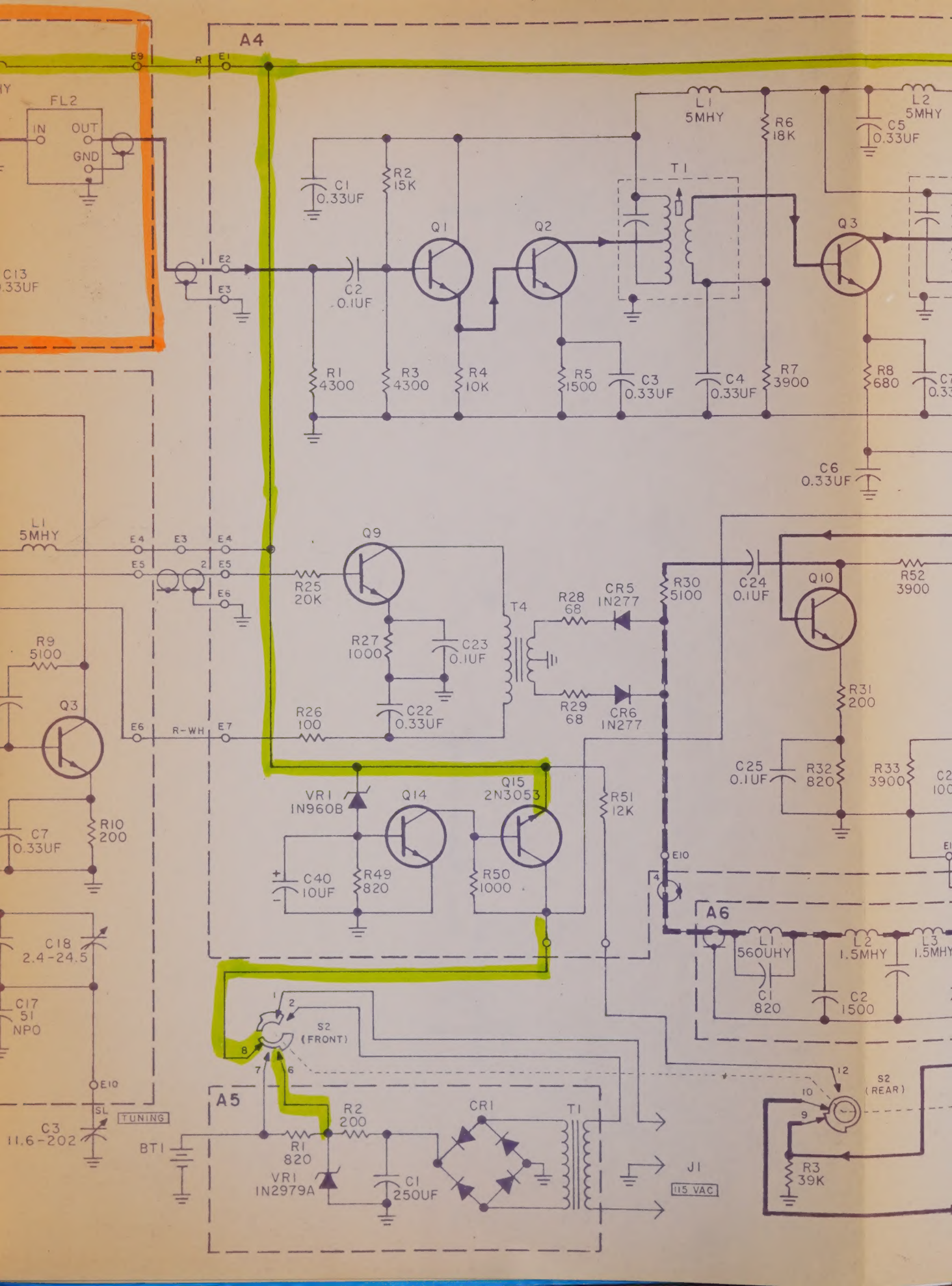
REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A5			
A5C1	Cap, 250 uF (-10%, +100%), 50 wvdc electrolytic. NOTE: Lead spacing differs in earlier units.	32-625-250 -T85°	29309	1
A5CR1	Diode, Bridge rectifier assy, 200 V PN 2.0 amp	S6230	84970	1
A5R1	Res, 820 ohms ±5%, 1/2 W, carbon	EB8215	01121	1
A5R2	Res, 200 ohms ±5%, 5 W, wire wound	4599	44655	1
A5T1	Transformer, power, stepdown	3085-1	18410	1
A5VR1	Diode, Zener, 15.0 volt, ±10%	1N2979A	04713	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A6 Serial No. 101-329			
A6C1	Cap, 910 pF ±5%, 500 wvdc, silver mica	DM19E911J	72136	1
A6C2	Cap, 1500 pF ±5%, 500 wvdc, silver mica	DM19E152J	72136	1
A6C3	Cap, 820 pF ±5%, 500 wvdc, silver mica	DM19E821J	72136	1
A6L1	Coil, rf, 560 uH	73F564AF	76493	1
A6L2	Coil, rf, 1.5 mH	73F153AF	76493	1

PARTS LIST

REF DES	DESCRIPTION	PART NO.	MFR	QTY/ ASSY
	MODULE A6A Serial No. 330 up.			
A6C1	Cap, 820 pF ±5%, 500 wvdc, silver mica	DM19E821J	72136	1
A6C2	Cap, 1500 pF ±5%, 500 wvdc, silver mica	DM19E152J	72136	1
A6C3	Cap, 1600 pF ±5%, 500 wvdc, silver mica	DM19E162J	72136	1
A6C4	Cap, 680 pF ±5%, 500 wvdc, silver mica	DM19E681J	72136	1
A6L1	Coil, rf, 560 uH	3095-11	18410	1
A6L2	Coil, rf, 1.5 mH	3095-12	18410	2
A6L3	Coil, rf, 1.5 mH, same as A6L2			


A4
E9
R
E1
FL2
IN
OUT
GND
C13
.33UF
E2
E3
C1
0.33UF
R2
15K
Q1
Q2
C2
0.1UF
L1
5MHY
R6
18K
T1
L2
5MHY
C5
0.33UF
Q3
R1
4300
R3
4300
R4
10K
R5
1500
C3
0.33UF
C4
0.33UF
R7
3900
R8
680
C6
0.33UF
L1
5MHY
E4
E3
E4
E5
E5
E6
R25
20K
Q9
T4
R28
68
CR5
IN277
R30
5100
C24
0.1UF
Q10
R52
3900
R27
1000
C23
0.1UF
R29
68
CR6
IN277
R31
200
R9
5100
Q3
R26
100
C22
0.33UF
E6
R-WH
E7
C25
0.1UF
R32
820
R33
3900
VR1
IN960B
Q14
Q15
2N3053
R51
12K
E10
C40
10UF
R49
820
R50
1000
C7
0.33UF
R10
200
A6
L1
560UHY
C1
820
L2
1.5MHY
C2
1500
L3
1.5MHY
C18
2.4-24.5
C17
51
NPO
E10
S2
(FRONT)
S2
(REAR)
R3
39K
A5
SL
TUNING
C3
11.6-202
BT1
R1
820
R2
200
VR1
IN2979A
C1
250UF
CR1
T1
J1
115 VAC